IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP v. COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP	Civil Action No. 2:05-cv-00443-TJW

ORDER

ON THIS DAY came on to be heard Plaintiff's Unopposed Motion for Leave to Exceed the Page Limits, and the Court is of the opinion that the Motion should be GRANTED.

Accordingly, IT IS ORDERED that the Plaintiff's Unopposed Motion for Leave to Exceed the Page Limits is GRANTED.

SIGNED this 29th day of December, 2006.

T. John Ward

T. JOHN WARD
UNITED STATES DISTRICT JUDGE

AUS:3857053.1
52670.1

DECLARATION
OF
HARRY V. BIMS, PH.D

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP, Plaintiff, v. COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS; LLC; and COMCAST OF PLANO, LP, Defendants.	Case No. 2:05cv443

DECLARATION OF HARRY V. BIMS, Ph.D. IN SUPPORT OF COMCAST'S RESPONSIVE CLAIM CONSTRUCTION BRIEF

I, HARRY V. BIMS, declare:

1. I make this declaration of my own personal knowledge. If called upon to testify as to the truth of the matters set forth herein, I could and would do so competently.

I. INTRODUCTION

2. I am currently employed by Protocom Systems, LLC (a company I founded in 1999) as a consultant on matters related to wireless technologies. I have more than twenty years experience in the telecommunications field.

3. I have been retained by Keker & Van Nest, LLP, counsel for Comcast Corporation ("Comcast"), as an independent technical expert with respect to United States Patent

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 3 of 18

Nos. 5,852,631 (the '631 patent) and 5,243,627 (the "'627 patent"). I am being compensated at an hourly rate of $350.00. My compensation is not contingent upon the outcome of this litigation.

II. PERSONAL BACKGROUND

4. My education and work experience are set forth in my curriculum vitae, a true and correct copy of which is attached as Exhibit 1.

5. I received a Bachelor of Science degree in Computer and Systems Engineering from the Rensselaer Polytechnic Institute in 1985. I subsequently received a Master's of Science degree in Electrical Engineering from Stanford University in 1988. I obtained my PhD. in Electrical Engineering from Stanford University in 1993. Both my Masters and Ph.D. studies concentrated on digital communications and various techniques related thereto.

6. My work experience related to electrical engineering began during my undergraduate studies in 1981, when I was employed by Bell Laboratories as an Associate Member of Technical Staff. I continued to be employed by Bell Laboratories as a student until 1986 working on various projects related to electrical engineering. Between 1992 and 1998, I was employed by Wireless Access, Inc. (later Glenayre Technologies, Inc.) in various capacities (member of the technical staff, senior member of the technical staff, manager of NOC systems) where I designed, developed, and managed products related to wireless paging systems.

7. Between 1999 and 2001, I was the Director of Software Architecture for Symmetry Communications Systems, Inc., where I designed and developed products related to wireless data services (general packet radio service, GPRS) for use with mobile phones, etc.

8. From 2001 to 2004, I was employed as Chief Technical Officer of AirFlow Networks, Inc., which I founded. At AirFlow Networks, I developed wireless products (base stations, repeaters, etc.) for use with IEEE 802.11 networks.

9. In addition to the above, through Protocomm Systems, I have consulted for various organizations (Magis Networks, Gigabit Wireless, and GW.com, for example) with respect to wireless systems generally and IEEE 802.11 networks in particular.

10. In addition, I am the author of several papers related to the coding used in

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 4 of 18

wireless networks. Also, I am the sole named inventor on five issued United States Patents (U.S. Patent Nos. 7,149,196; 6,862,448, 6,788,658, 6,760,318, and 6,557,134) and the co-inventor on two issued patents (U.S. Patent Nos. 6,259,911 and 6,965,769) all of which are related to wireless systems (*e.g.*, base stations, repeaters, and paging systems). Further, I am the sole named inventor on several pending patent applications covering the same technology.

III. MATERIALS REVIEWED AND RELIED UPON

11. I understand that Rembrandt Technologies, LP ("Rembrandt") accuses Comcast of infringing the '631 patent and the '627 patent. In connection with my work on this matter and in forming the opinions expressed in this declaration, I have reviewed the following items: (1) the '631 patent and the '627 patent; (2) the patents' prosecution histories; (3) the prior art cited in the prosecution histories; (4) various dictionaries, treatises, and other publications available to persons skilled in the art at the time of the filing of the '631 and/or '627 patent applications that provide guidance as to the meaning of certain claim terms in the patents; (5) the First Amended Joint Claim Construction and Pre-Hearing Statement the parties filed with the Court; (6) the deposition transcript of Dr. Rhyne; and (7) Rembrandt's Claim Construction Brief and supporting declarations and exhibits.

IV. EXPERT ASSIGNMENT

12. I have been advised that Claims 1 and 3-10 of the '631 patent and Claims 9 and 19 of the '627 patent have been asserted by Rembrandt in this litigation. In addition, I understand that only certain terms in these claims are in dispute. Counsel for Comcast has requested that I render an expert opinion on the appropriate interpretation for some of these disputed terms. Where one claim term appears in more than one claim, I have not repeated the construction of that term based on the understanding that the terms will be construed in the same manner in each claim.

13. I have been advised by counsel for Comcast that the claims of a patent are to be construed from the perspective of a person of ordinary skill in the art. The relevant art implicated by the '631 patent is electrical engineering and telecommunications. The relevant art implicated by the '627 patent is digital communications and signal processing. In my opinion, a

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 5 of 18

person of ordinary skill in these fields would be a person with at least a bachelor's degree in electrical engineering, along with coursework in communications theory, followed by three to five years of work experience, or someone with at least a master's degree in electrical engineering with coursework in communications theory, and at least two to three years of industry experience. My discussion below of the appropriate claim constructions for the disputed '631 and '627 patent claim terms is from the perspective of such a person of ordinary skill in the art.

V. TECHNICAL BACKGROUND RELATED TO THE '631 PATENT

14. The '631 patent describes a method for reducing the amount of time that is required for two modems to establish a link layer connection. Specifically, the patent describes a system where two modems "negotiate" the modulation that is needed to establish a physical layer connection. During this negotiation, which occurs when the modems first initialize, the modems exchange information regarding their physical layer connection capabilities in order to find a mutually acceptable physical layer modulation. Once the modems agree on the overall modulation, they then work to refine the specific parameters that will be employed, during a sequence that the patent refers to as the "modem startup and training phase." Once this phase is completed, the modems will have established a physical layer connection that allows them to exchange bits of data. The key feature of the '631 patent is that, rather than separately negotiate the link layer connection, the modems use information derived from the physical layer negotiation to establish a default link layer connection.

VI. THE '631 CLAIMS AT ISSUE

A. "Negotiated Physical Layer Modulation"

15. I understand that the parties have agreed upon a construction for the term physical layer modulation and that the parties' dispute with regard to this term is focused on the term "negotiated".

16. The process of negotiation described in the patent specification and prosecution history necessarily requires an exchange of information between the two modems. Negotiation of the physical layer modulation occurs during the Automatic Mode Synchronization ("AMS")

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 6 of 18

sequence. '631 at 6:28-36; 11:41-42; Fig. 2. According to the specification, "this sequence is executed by exchanging signals between the calling modem and the answer modem." '631 at 6:67–7:2. During this period, "the modems exchange parameters that identify the modems, and thus, their communication protocol." '631 at 6:32-33. It is only through this exchange of information that the modems are able to accommodate one another and agree on a common supported physical layer modulation. *See* Figs. 4-7.

17. In my opinion, Rembrandt's proposed construction of this term, which seeks to define negotiation as a "process," is vague and imprecise when compared with both the ordinary and customary meaning of the term "negotiate" in the telecommunications field and the description of "negotiation" contained in the '631 patent itself. Rembrandt's construction would seemingly apply to any method by which modems select a physical layer modulation. In contrast, Comcast's proposed construction comports both with the standard usage of the term "negotiate" and the use of the term within the '631 patent.

B. "Link Layer"

18. "Link layer," as defined in the '631 patent specification, is "the second lowest layer of the OSI seven layer model and is provided to perform error checking functions as well as retransmitting frames that are not received correctly." '631 at 1:51-54. In my opinion, the patentee's (and Comcast's) definition of link layer is consistent with how the term is understood and used by persons of ordinary skill in the art. This ordinary and customary meaning of the term "link layer" is reflected in numerous technical dictionaries. A few such dictionaries are THE COMMUNICATIONS HANDBOOK 573 (Jerry D. Gibson, ed.) (1996); ANDREW S. TANENBAUM, COMPUTER NETWORKS 30 (3d ed. 1996); and EDWARD A. LEE, DIGITAL COMMUNICATION 679 (1988).

19. In my opinion, Rembrandt's proposed construction of the term "link layer," specifically the phrase "to detect and correct errors that can occur in the physical layer," is too vague of a definition to capture the ordinary and customary meaning one of ordinary skill in the art would attribute to this term. Rembrandt's construction would encompass as part of the link layer any form of error correction that operates on errors in the physical layer. However, as

depicted in the '631 specification and understood by one of ordinary skill in the art, nearly all physical layer protocols include within them some form of error correction to correct for errors that occur in the physical layer. For example, V.34, which the patent lists as a physical layer protocol, includes within it a common form of error correction known as trellis coding. '631 at 2:6. Rembrandt's construction for link layer would apply equally to both error correction at the physical layer as well as at the link layer, and is therefore inconsistent with what one of ordinary skill in the art would understand the term "link layer" to mean.

20. Comcast's proposed construction, in contrast, is consistent with the customary and ordinary meaning of "link layer" because it specifies that the most commonly understood method of error correction at the link layer is error detection and retransmission of frames that are not received correctly from the physical layer. As generally understood by persons of ordinary skill in the art, the error correction function performed at the link layer is to detect errors in transmitted frames and request a retransmission of those frames. This is fundamentally different than forward error correction of errors that can occur at the physical layer using an error correction code such as trellis code or Reed-Solomon Code. In my opinion, Comcast's construction captures this distinction, while Rembrandt's construction incorrectly combines what is happening at the physical layer with what is happening at the link layer.

21. During my deposition in this matter, Rembrandt's attorney asked me a number of questions regarding a particular statement from an unrelated patent of mine, United States Patent No. 6,259,911 (the "911 patent"): "Data link layer (Layer 2) 408 looks the same for all protocols. In one embodiment, data link layer 408 is implemented for inbound channels in device driver 304 with Reed-Solomon decoding of the inbound data packets, check-sum verification and packet identification." '911 at 8:5. I understand that Rembrandt has taken the position that this statement lends support to its definition of "link layer." This is incorrect. As I explained during my deposition, the '911 patent does not disclose Reed-Solomon decoding at the link layer. In the particular embodiment of the '911 patent that Rembrandt is focusing on, the link layer is implemented in a device driver that is also performing Reed-Solomon decoding. However, in my opinion, one of skill in the art would understand that Reed-Solomon encoding or

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 8 of 18

decoding is a physical layer characteristic that is not being implemented in the link layer. In this embodiment, the device driver is simply implementing multiple layers. Therefore, the '911 patent does not support Rembrandt's proposed construction of "link layer."

22. In connection with my work on the '631 patent, I have reviewed the article entitled *Performance Analysis of CDMA_ALOHA/FEC Scheme in the Centralized Packet Radio Networks*, which Rembrandt cites as extrinsic support for its construction of "link layer" (attached to Rembrandt's Opening Claim Construction Brief as Exhibit 20). In my opinion, by purporting to place a block forward error correction ("FEC") code in the link layer, the authors of this article were proposing an unconventional scheme that would not have been readily understood by persons of skill in the art. In my opinion, it is commonly understood in the art that FEC is a physical layer characteristic.

23. In connection with this case, I have reviewed the High-level data link control ("HDLC") standard, which is cited in the Hubert Zimmerman article regarding the OSI Reference Model. HDLC is a data link layer protocol developed by the International Organization for Standardization, originally as ISO 3309. The protocol defines a procedure to transmit frames of data using a particular structure. The error control mechanism in HDLC uses an error checking pattern called a frame check sequence. The receiver uses this sequence to detect errors. The transmitter will resend a frame if the receiver indicates an error (through a negative acknowledgment message sent back to the transmitter) or if no acknowledgment is received after a certain time-out period. No forward error correction (FEC) code such as Reed-Solomon coding or Trellis coding is used in HDLC.

24. In connection with this case, I have reviewed the V.42 standard, which is the primary example of a link layer protocol discussed in the '631 patent specification. The error control mechanism disclosed in the V.42 standard is error detection through the use of a cyclic redundancy check, and error correction through the use of automatic retransmission of data. No forward error correction (FEC) code such as Reed-Solomon coding or Trellis coding is used in HDLC.

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 9 of 18

C. Means-plus-function claim elements (Claims 6 and 9)

25. I have been informed by counsel for Comcast that the parties agree that three claim elements in the '631 patent should be construed as "means-plus-function" elements under 35 U.S.C. § 112, ¶ 6. I have been further informed by counsel for Comcast that when construing a "means-plus-function" element under this statutory provision, the Court must identify both the function and the corresponding structure of each "means" element.

26. I have been asked by Comcast to identify the corresponding structure disclosed in the specification that performs the function of the three means-plus-function claim elements.

1. "Means for establishing a physical layer connection…"

27. Claim 6 of the '631 patent contains the following limitation that the parties agree should be construed as a means-plus-function limitation: "means for establishing a physical layer connection between said calling and said answer modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations."

28. The parties agree that the function performed by this limitation is "establishing a physical layer connection based on a negotiated physical layer modulation." The structure necessary to perform this function is the control processor shown in Figure 9 running the algorithms defined by the flowcharts of either Figures 4 and 5 taken as a pair, or Figures 6 and 7 of the '631 patent taken as a pair.

29. By listing Figures 4-7 as four independent algorithms that are capable of performing the claimed function, Rembrandt's construction fails to acknowledge that in order to perform the function of establishing the physical layer connection, both a calling and answering modem must perform an algorithm of the sort described in Figures 4-7 of the patent. Thus, Figures 4-7 represent not four alternative algorithms, each standing alone, but two alternative pairs of interdependent algorithms (*i.e.*, Figure 4 linked with Figure 5, and/or Figure 6 linked with Figure 7).

2. "Means for establishing said link layer connection based on …"

30. Claim 6 of the '631 patent also contains the following limitation that the

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 10 of 18

parties agree should be construed as a means-plus-function limitation: "means for establishing said link layer connection based upon said negotiated physical layer modulation." The parties agree that the function performed by this limitation is "establishing the link layer connection based upon the negotiated physical layer modulation." The only structure disclosed to perform this function is the control processor shown in Figure 9 running an algorithm that "preset[s] the XID phase parameters to default values that are based upon the negotiated physical layer connection," as described generally at column 12, lines 59-61. However, the '631 specification does not disclose any specific algorithm or other structure that shows how the control processor accomplishes the presetting of these parameters based on the negotiated physical layer modulation.

31. Rembrandt's proposed construction simply defines a general-purpose computing system, *i.e.* "programmable hardware," programmed to perform the claimed function. Rembrandt's proposed construction does not connote any particular structure to one of ordinary skill in the art. Specifically, it does not provide any guidance as to how the link layer connection is established based on the negotiated physical layer modulation, or the particular logic or algorithm necessary to perform the function of this element.

3. "Means for presetting link layer parameters of said link layer connection ..."

32. Claim 9 of the '631 patent contains the following limitation that the parties agree should be construed as a means-plus-function limitation: "means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation." The parties agree that the function performed by this limitation is "presetting link layer parameters based on the negotiated physical layer modulation." The only structure disclosed to perform this function is the control processor shown in Figure 9 running an algorithm that "preset[s] the XID phase parameters to default values that are based upon the negotiated physical layer connection," as described generally at column 12, lines 59-61. As an example, the specification lists the XID phase parameters for the V.42 protocol as "Standard Reject", "16 bit FCS", "V.42bis compression disabled", "Frame Length", and "Window Size". '631 at 12:14-18. However, the '631 specification does not

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 11 of 18

disclose any specific algorithm or other structure that shows how the control processor accomplishes the presetting of these parameters based on the negotiated physical layer modulation.

VII. TECHNICAL BACKGROUND RELATED TO THE '627 PATENT

33. The '627 patent is concerned with correcting errors at the bit, or physical layer, and specifically with a method to correct errors and signal distortion that occur when digital data is transmitted at high bit-rates over a communications channel. '627 at 1:7-10. This patent involves a combination of two different types of error correction: "trellis encoding" and interleaving. *Id.* at 2:5-14.

34. Over the years, various techniques have been developed for correcting errors caused by signal distortion. Many of these techniques, including the trellis encoding and interleaving techniques described in the '627 patent, are grounded in the process of encoding data into channel symbols, which represent the data during transmission. Depending on the nature of the channel symbol, each symbol may consist of one or more "signal points," although every claim of the '627 patent requires a "plurality of signal points" comprising each channel symbol.

35. Signal points are defined by a "signal constellation," an example of which is shown in Figure 2 of the '627 patent. '627 at 3:5-8. In this "two-dimensional" constellation, each of the 32 points is a signal point corresponding to a particular five bit binary number, such as 00001. *Id.* at 3:20-35. Each signal point corresponds to certain waveform characteristics (*e.g.*, amplitude, frequency, etc.), and as such can be transmitted over the medium (*e.g.*, a wire).

36. At the receiver, the waveform must be essentially plotted back onto the signal constellation in an attempt to decode what binary data the waveform represents. Errors arise when the plotted waveform does not fall directly on a point in the constellation, and the decoder makes the wrong "guess" about the original data.

37. Error correction using trellis encoding, which was well-known in the art and itself is not described in detail in the '627 patent, attempts to narrow the possible valid signal points for every channel symbol, and thereby reduce the likelihood of an incorrect decoding. A trellis

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 12 of 18

encoder includes a memory that saves a record of some data from the previously encoded symbol. Trellis encoding uses this record from the past to encode the next symbol. It does so by "expanding" the number of bits entering the encoder based, in part, on its memory of the last encoded symbol, to generate a set of bits that interdependently define the signal point(s) of the symbol. This creates a sort of historical path of the data stream. The receiver can use this path to eliminate many possible points in the constellation, and thus greatly increase the chance for a successful decoding of the received waveform. With each symbol, the state of the trellis encoder's memory is updated to reflect the last encoded symbol.

38. One description of a trellis encoder is found in a patent to Lee-Fang Wei, U.S. Patent No. 5,559,561 ("the '561 patent"), cited by Rembrandt as extrinsic evidence to this patent, which I reviewed in connection with forming my opinions in this case. Figure 4 of the '561 patent shows the structure of a trellis encoder. The two inputs to the encoder are represented by the bottom two lines: Y2n and Y1n. The memory structure is represented by the boxes "4T," which retain the value from the last values on Y2n and Y1n.

39. The values on Y2n and Y1n are "Exclusive OR'd" (a Boolean logic function) together with the data in the memory elements to generate the third output, Y0n. In other words, the two input values, Y2n and Y1n, are expanded into three output values. All three, Y2n, Y1n and Y0n, are output in parallel, as they entered the encoder, during one "symbol interval." During this symbol interval the memory elements have not changed state. '561 at 4:54-63. These three simultaneously encoded bits are then used to "select a particular symbol." '561 at 5:9. Thus, the encoder has created an extra bit that will define a channel symbol based on data that was previously encoded. This "symbol selection" process described in the '561 patent also is described in the '627 patent with respect to the "two dimensional" codes of Figure 2 ('627 at 3:19-35) and "2N dimensional" codes ('627 at 3:53-68).

40. Another patent to Wei, U.S. Patent No. 5,214,656, also depicts and describes the "expansion" function of a trellis encoder at Figure 3 and column 6, lines 26-37.

41. Because the power of trellis encoding depends upon creating an historical path or sequence of potentially valid symbol values, if a number of consecutive bits of data are corrupted

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 13 of 18

the historical sequence becomes corrupted and of little use for decoding. One way of correcting for this effect is interleaving.

42. Interleaving shuffles the data to be transmitted so that it is not in the same order as it was composed by the transmitting computer device. Because only interleaved data is transmitted, a disruption to two adjacent channel symbols during transmission will not result in adjacent corrupted data during decoding. This allows the decoder to recover from the first corrupted symbol before attempting to decode the second corrupted symbol.

43. Interleaving, like trellis-encoding, was well-known in the prior art. The '627 patent claims to improve upon the interleaving technique of Mr. Betts' earlier '625 patent to improve error correction performance in systems using four-dimensional or higher codes. '627 at 2:5-13. Specifically, the '627 patent interleaves first the channel symbols, and then proceeds to interleave the "plurality of signal points" that comprise each channel symbol.

44. Viterbi decoding refers to a complex algorithm developed by Andrew Viterbi to decode a received modulated waveform more accurately. Viterbi decoding also was well-known in the art at the time of the '627 patent.

45. The Viterbi algorithm is a method for calculating the mapped signal point that is most likely to correspond to a received waveform by essentially determining the closest valid signal point to the actual plotted waveform. Narrowing the possible signal points down to only those that are "valid" is where trellis encoding comes in. As noted above, because the trellis encoding at the transmitter used the previous one (or more) symbols to select the signal point, the decoder can use the sequence of the recently decoded symbols to narrow the field of possible valid signal points.

VIII. THE '627 PATENT CLAIMS AT ISSUE

A. "Trellis encoded channel symbol"

46. In my opinion, Comcast's proposed construction of this claim term accurately reflects the channel symbol encoding process described in the specification, as well as the ordinary and customary meaning of "trellis encoded channel symbol."

47. The specification is clear that the "trellis encoded channel symbols" appear at one

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 14 of 18

point: the output of the mapper, labeled "4-D QAM encoder" in Figure 3, on lead 325. '627 at 5:24-30. The inputs to the mapper/ 4-D QAM encoder are not yet trellis encoded channel symbols, but rather "subset identifiers" (line 338), generated by the trellis encoders, and "index values" (line 317), which are generated by the "modulus converter" (block 316). '627 at 4:61-62. Consequently, only at the output of the mapper have the "subset identifiers" and "index values" been used to select a trellis encoded channel symbol, as Comcast proposes.

48. Additionally, any given "trellis encoded channel symbol" is defined by the operation of the trellis encoder itself, not merely whether some data has been "treated as a unit" as Rembrandt would suggest. A particular channel symbol is a product of the "subset identifier(s)" from a trellis encoder and the index values with which they are paired. *See* '627 at 3:20-35 (2-dimensional code); '627 at 3:63-68 (4-dimensional code).

49. The key feature of a trellis encoder that demarcates one trellis encoded channel symbol from another is the state transition of the trellis encoder memory. During one state transition the encoder may output multiple bits, but the memory does not change during this time. And all of the parallel bits from the encoder—subset identifiers in the '627 patent—are used in the mapper to select a particular trellis encoded channel symbol. When the symbol interval ends, and the next trellis state transition occurs, the encoder has moved on to the next symbol.

50. The specification explains how this process works in the case of both a two-dimensional and a four-dimensional coding scheme. '627 at 3:20-35 (2-dimensional code); 3:63-68 (4-dimensional code). In the four-dimensional case, the trellis encoder "expands" a set of three input bits into four output bits "to identify a pair of subsets" of the signal constellation (the signal constellation shown in Figure 2 is partitioned into four subsets, labeled A-D), while six "index value" bits from the modulus converter "are used to select particular signal points from those two subsets." '627 at 3:63-68. In other words, the trellis encoder's operation of expanding a set of three input bits into four output bits simultaneously identifies a pair of subsets, which in turn are used to create the signal points comprising a trellis encoded channel symbol.

51. In connection with forming my opinion regarding the construction of this claim

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 15 of 18

term, I reviewed the prior art United States Patent No. 5,052,000 ("the '000 patent). The '000 patent explains the relationship of a trellis encoder to generating a channel symbol as follows:

> When a trellis code is designed, the coded (redundant) signal constellation is portioned into increasingly smaller subsets .... For [a 32-point] signal constellation ... this portioning can, for example, divide the 32 points into subsets A and B which have 16 points each ... In any given symbol period, only one of the two subsets, either A or B, can be used to select the symbol that is to be transmitted over the channel. *The subset that has to be used is determined by the so-called state of encoder during this symbol period. Transition from one state, in a given period, to another, in the next symbol period, is not arbitrary and is defined by the selected convolutional encoder.*

'000 at 7:3-24 (emphasis added). Thus, according to the prior art '000 patent, which in my opinion accurately summarizes the trellis encoding process, a channel symbol is "determined by the ... state of the encoder," and the state of the encoder changes with each new channel symbol to be encoded.

52. I understand that Rembrandt has attempted to attack Comcast's construction by pointing to language in the specification suggesting that a channel symbol is derived from a "succession of outputs," and by claiming that I admitted during my deposition that each of these "outputs" "corresponds to a separate state change." In making this argument, Rembrandt misconstrues both the '627 patent specification and my testimony.

53. The "succession of outputs" referenced in the specification, at column 4, lines 19-24, is simply the pairs of two-dimensional subset identifiers (two pairs in the four-dimensional coding example) interdependently generated by the trellis encoder's expanding the set of input bits (three in the four-dimensional example). The patent is clear that data is input into the trellis encoder in parallel. '627 at 3:65-67. And it is well-known in the art that the subset identifiers associated with a single trellis encoded channel symbol are generated from a trellis encoder in parallel. The trellis encoder memory remains the same during the processing of the all of the subset identifiers that define a given trellis encoded channel symbol. Consequently, during my deposition, I testified that each time the trellis encoder outputs the set of interdependently-generated subset identifiers that determine the trellis encoded channel symbol—which I collectively referred to as a "value"—there needs to be a new state change. I never testified, nor would I have because it would be incorrect, that the generation of each individual subset

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 16 of 18

identifier requires a separate trellis state change.

54. In sum, it is my opinion that one of ordinary skill in the art reading the '627 patent would understand the term "trellis encoded channel symbol" to mean "the output of a mapper that is generated using the output(s) of a single state transition of a trellis encoder."

B. "Signal point"

55. In my opinion, Comcast's proposed construction of the term "signal point"—"a single mapped point in a signal constellation"—is consistent with both the explanation of the term provided in the '627 patent specification and the customary usage of the term by persons of skill in the art.

56. According to the specification, a signal point is a single mapped point in a signal constellation. The specification states that Figure 2 "shows the two-dimensional signal constellation that forms the basis of the 2N-dimensional signaling scheme illustratively used by the modem." The specification then goes on to state: "This constellation is comprised of 32 signal points, which are divided into four subsets, A through D, each comprised of eight signal points." '627 at 3:5-9.

57. Furthermore, the term "signal point" is not unique to the '627 patent; it is a widely-used term in the digital communications field. In my experience, whenever the term "signal point" is used it is used to refer to a single mapped point in a signal constellation.

58. For example, the prior art '000 patent explains that in "quadrature amplitude modulation (QAM)"—a two-dimensional signaling scheme—"[e]ach signal point in the [signal] constellation has an associated bit code. For example, signal point 304 has the code 1111" '000 at 2:60-64; *see also id.* Fig. 3. Thus, the '000 patent uses the term "signal point" to refer to a mapped point in a signal constellation.

59. Similarly, U.S. Patent No. 5,559,561 ("the '561 patent"), cited by Rembrandt, describes a one-dimensional signal constellation and explains that "[e]ach signal point is a point in a predetermined one-dimensional base constellation." '561 at 3:24-25.

60. Additionally, Richard D. Gitlin, DATA COMMUNICATIONS PRINCIPLES 355 (1992) describes the use of a "four-dimensional constellation of 256 signal points."

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 17 of 18

61. In addition to failing to capture the customary meaning of "signal point," Rembrandt's construction is inaccurate in my opinion. A "signal point" is not "what is transmitted," as Rembrandt's construction suggests. Rather a modulated waveform representing the numeric bit values associated with a signal point is what is actually transmitted by the transmitter to the receiver.

C. "Means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols"

62. I understand that the parties agree that this claim element is to be construed pursuant to 35 U.S.C. § 112, ¶ 6. However, it is my understanding that the parties disagree both as to the proper construction of this term's function and the corresponding structure disclosed in the specification.

63. In my opinion, Rembrandt's proposed construction of the function of this claim element is inaccurate. Reversing the entire "process of interleaving performed in the transmitter" is not the function of this element. The specification describes two kinds of interleaving that occurs at the transmitter: symbol interleaving and signal point interleaving. The function of this element is limited to reversing the interleaving—*i.e.,* to deinterleave—of the interleaved signal points, and does not address the interleaving of the symbols.

64. Rembrandt's proposed structure also is inaccurate. Rembrandt proposes that the structure may be *either* the "signal point deinterleaver 441" *or* the switching circuit 431. But the specification explains that: "[t]he successive received signal points are deinterleaved in signal point interleaver 441, which provides the opposite function to [signal point] interleaver 341 in the transmitter." '627 at 5:67-6:2.

65. The specification also states that Figure 7 "shows the structure of a deinterleaver 741 that could be used in the receiver of FIG. 4 in place of deinterleaver 444 in order to restore *the signal points* of the eight-dimensional channel symbols to their original order." '627 at 9:45-51.

66. Only after signal point deinterleaver 441 (or 741) performs this function are the signal points sent to the switching circuit 431: "The received signal points on lead 442 are then

Case 2:05-cv-00443-TJW-CE Document 122-1 Filed 01/10/2007 Page 18 of 18

distributed by switching circuit 431 ... to a distributed Viterbi decoder ...." '627 at 6:12-14. Switching circuit 431, by itself, cannot deinterleave the interleaved signal points.

I swear under penalty of perjury under the laws of the United States that the foregoing is true and correct, and that I executed this declaration on January 10, 2007, at Menlo Park, California.

By: Harry Bims

Harry V. Bims, Ph.D.

EXHIBIT 1A
OF
DECLARATION
OF
HARRY V. BIMS, PH.D

Case 2:05-cv-00443-TJW-CE Document 122 Filed 01/10/2007 Page 2 of 7

Dr. Harry V. Bims
1314 Chilco Street
Menlo Park, CA 94025
protocomm@att.net
650-283-4174

PROFESSIONAL SUMMARY

Harry Bims, PhD, EE, provides exceptional expert witness support services for telecommunications-related intellectual property litigation. These services include deposition and court testimony, expert reports, and infringement research, for patent, copyright, and trade secret litigation matters. He has 12+ years of telecommunications industry experience, and holds three US patents in network architecture and chip design for wireless communications.

EMPLOYMENT HISTORY

12/2001 - 05/2004 **AirFlow Networks, Inc. LLC • Sunnyvale, California**

Position: *CEO/CTO & Founder*

As the sole founder of the company, created the original business plan, raised venture capital, and hired the core engineering team. Grew the company to 32 people and shipped products for revenue in the US and overseas. Three patents on the core technology have issued. These patents, which relate to wireless network infrastructure based on the 802.11 specification, have been sold to Broadcom.

03/2001 - 12/2001 **Bay Partners LLC • Cupertino, California**

Position: *Entrepreneur in Residence*

Reported to the partners of this VC firm as a technology expert on a range of wireless and networking subjects. Reviewed business plans and participated in due diligence activities related to several startups seeking funding. Developed a business plan for a startup that builds network infrastructure for 802.11 enterprise networks.

09/1999 - 03/2001 **Symmetry Communications Systems LLC • San Jose, California**

Position: *Director, Software Architecture*

Reporting to the CEO, responsible for the software architecture of their

Case 2:05-cv-00443-TJW-CE Document 122 Filed 01/10/2007 Page 3 of 7

core SGSN and GGSN products for the GPRS market. Formulated a software technology roadmap, showing the evolution from 2.5G to 3G SGSN and GGSN products. Management responsibility for Firmware, Hardware, Performance, and Systems Engineering Groups. Provided management support of early field trials of the system on a global basis.

07/1999 - 09/1999 **T-SPAN Systems Corporation LLC • Palo Alto, California**

Position: *Member of Technical Staff*

Designed a wireless home LAN protocol for the company. Also designed and built a PC-based platform to demonstrate their technology. Company is now publicly traded as Atheros Communications.

07/1992 - 12/1998 **Glenayre Technologies-Wireless Access Group • San Jose, California**

Position: *Member of Technical Staff; Sr. Member of Technical Staff; Manager of NOC Systems*

Employee #6 at the company, which was acquired by Glenayre Technologies, Nov 1997. Designed and built a 4-channel ReFLEX50 pager demonstration in 1 week. Participated in early field trials and feasibility studies, culminating in a Pioneer's Preference license award from the FCC to SkyTel Corporation for Narrowband PCS development.

Invented, designed, and built from concept through full implementation, a patented two-way pager test system for the ReFLEX50 and ReFLEX25 protocols. This system was used throughout company operations for performance testing of the ReFLEX pager designs from Wireless Access, and Motorola. Over 16 systems were deployed around the country for manufacturing tests, engineering protocol tests, antenna tests, and pager repair tests.

The project required technical skills in PC hardware design, C++, object-oriented programming, signal processing techniques, NT device driver development, Win32 user interface development, real-time, multi-threaded control, and proficiency with wireless communications lab equipment. Three patents have been issued based on technical inventions in this capacity.

Co-developed a wireless application protocol for sending and receiving encrypted email messages over the paging channel. Led the project team that deployed a software encryption module based on this protocol for government agencies.

Case 2:05-cv-00443-TJW-CE Document 122 Filed 01/10/2007 Page 4 of 7

Protocomm Systems, LLC Consulting History

12/2003 – Present **Protocomm Systems, LLC • Menlo Park, California**

Position: *Wireless Network Research Consultant*

Performing ongoing research into next-generation wireless network architectures. Includes the hardware and software implementation of wireless communications protocols. Expert witness and consulting expert for patent infringement trials.

04/1999 - 07/1999 **Gigabit Wireless, Inc. • San Jose, California**

Position: *Technical Leader*

Technical leader for the Wireless MAC design group. Responsible for comparative analysis of competing wireless MAC protocol standards. Responsible for the creation of a proprietary MAC protocol specification document, simulation of the protocol, and implementation in a prototype. Participated in early 802.16 protocol standards. This company was acquired by Intel Corporation.

01/1999 - 04/1999 **GWcom, Inc. • Santa Clara, California**

Position: Technical Leader

Technical leader for the design of their next-generation NPCS protocol for the PLANET two-way paging system. Protocol includes Physical Layer, MAC Layer, and Link Layers. Solely responsible for creating the specification document, and simulation modeling of the protocol. Responsible for new scheduling algorithms in the infrastructure equipment to take advantage of the protocol features.

Litigation Support Experience

6/2006 - Present **Client: Ericsson, Inc.**

Case: Fenner Investments, Ltd., v. Juniper Networks, Inc. et. al.
Case No. 2:05–CV–05 JDL

Location: UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS

Case 2:05-cv-00443-TJW-CE Document 122 Filed 01/10/2007 Page 5 of 7

Testifying expert in this case involving wireless communications services.

Status: Case ongoing

12/2003 - Present **Client: McKesson Information Solutions, Inc.**

Case: McKesson Information Solutions, Inc. vs. Bridge Medical, Inc.
Case No. CIV S-02-2669 FCD KJM

Location: UNITED STATES DISTRICT COURT EASTERN DISTRICT OF CALIFORNIA

Testifying expert in this case involving a patient on a patient identification and verification system that incorporates wireless technology.

Inequitable Conduct Trial live testimony:
5-04-06

Markman Hearing live testimony:
6-29/30-05

Videotaped Depositions:
2-14-04, 6-3-05

Declarations:
12-1-03 Dec. in support of MISI's Opening/Opposition re Claim Construction
12-24-04 Dec. in support of MISI's Motion for Preliminary Injunction
3-1-04 Dec. in support of Claim Construction
6-29-04 Dec. re meaning of "Communication"
7/15/05 Dec. in support of MISI's Opposition to Bridge's Motion for Summary Judgment

Status: Case pending appeal.

07/2003 - 02/2006 **Client: Texas Instruments, Inc.**

Case: Texas Instruments, Inc. and Stanford University vs. GlobespanVirata, Inc.

Provided discovery of evidence used at trial, concerning the structure and operation of Globespan's ADSL products, and supported litigators in depositions of Globespan engineers.

Status: Case settled.

Patents

Patent Number	Date Issued	Title
6,965,769	Nov 15, 2005	Testing Center
6,862,448	Mar 1, 2005	Token-based receiver diversity
6,788,658	Sep 7, 2004	Wireless communication system architecture having split MAC layer
6,760,318	Jul 6, 2004	Receiver diversity in a communication system
6,557,134	Apr 29, 2003	ARQ method for wireless communication
6,259,911	Jul 10, 2001	Network operations center hardware and software design

Education

Year	College/University	Degree
1993	Stanford University	PhD, Electrical Engineering
1988	Stanford University	MS, Electrical Engineering
1985	Rensselaer Polytechnic Institute	BS, Computer and Systems Engineering

Publications

Bims, Harry. "Surveying the Wireless LANdscape. Or Why Large Wi-Fi Networks Require Good Planning." Xchange. [Online] Available http://www.xchangemag.com/articles/391supsys1.html, September 1, 2003.

Bims, Harry. "Building Voice-Ready Wireless LANs" Wireless Week. [Online] Available http://www.wirelessweek.com/article/CA319429.html?spacedesc=Departments, September 1, 2003.

Bims, H. and Cioffi. J. "Trellis Coding for Full-Response CPM", *Third Generation Wireless Information Networks*, Kluwer Academic Publishers, 1992.

Bims, H. and Cioffi. J. "Trellis Coding for Full-Response CPM", *WINLAB WORKSHOP*, East Brunswick, NJ. October 18-19, 1990.

Bims, H. and Cioffi, J. "Trellis Coding for Partial-Response CPM", *1991 International Symposium on Information Theory*, Budapest, Hungary. June 24-28, 1991.

Bims, H. and Cioffi, J. "Trellis Coding with M-ary MSK Constraints", *GLOBECOM '89*, Dallas TX. Nov. 1989.

Professional Associations and Achievements

- Feb 2002 – Present Member, City of Menlo Park Planning Commission (2006 Chairperson, 2005 Vice-Chairperson)
- Jan 1996 – Present Member, IEEE Society
- Jan 2000 – Dec 2000 Chair, IEEE Engineering Management Society – Silicon Valley Chapter
- Jun 1985 - Jun 1991 AT&T Bell Laboratories Cooperative Research Fellow

DECLARATION

OF

CURTIS A. SILLER, JR., PH.D.

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 2 of 15

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP,

Plaintiff,

v.

COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS; LLC; and COMCAST OF PLANO, LP,

Defendants.

Case No. 2:05cv443

DECLARATION OF CURTIS A. SILLER, JR., Ph.D. IN SUPPORT OF COMCAST'S CLAIM CONSTRUCTION BRIEF

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 3 of 15

I, CURTIS A. SILLER, JR., declare:

1. I make this declaration of my own personal knowledge. If called upon to testify as to the truth of the matters set forth herein, I could and would do so competently.

I. Introduction

2. I am currently employed as Chief Technology Officer at Rivulet Communications, Inc. I am also principal of Enginnovation, LLC, an independent consulting firm I founded. I have more than thirty-five years experience working with telecommunications networks.

3. I have been retained by Keker & Van Nest, LLP, counsel for the defendant Comcast entities (collectively, "Comcast") in this matter, as an independent technical expert to render my opinions with respect to United States Patents Nos. 5,719,858 ("the '858 Patent") and 4,937,819 ("the '819 patent").

4. I understand that Rembrandt asserts claims 1, 7-11, 15, 20, and 26 of the '858 patent and claims 1-2, 11-12, and 14 of the '819 patent in this case. I also understand that parties have raised certain disputed terms in these claims for construction by the Court. I have been requested by counsel for Comcast to render my expert opinions on the appropriate interpretation for some of these disputed terms. Where the same term appears in more than one claim, I understand that such term will be construed in the same manner in each claim.

5. I have been advised that claim terms are to be construed from the perspective of a person of ordinary skill in the relevant art. Both the '858 and '819 patents are in the general field of electrical engineering and telecommunications. In my opinion, a person of ordinary skill in the art relevant to the '819 patent would be someone with at least an accredited bachelor's degree in electrical or computer engineering, including course work in communications systems networks; and at least two years work experience related to coaxial or hybrid fiber-coaxial cable networks. A person of ordinary skill in the art relevant to the '858 patent would be someone with at least an accredited bachelor's degree in electrical or computer engineering, including course work in signal processing and communication networks; and at least two years work experience in design or development of voice and data communications network equipment. My

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 4 of 15

opinions below regarding the disputed claims terms are from the perspective of such a person of ordinary skill in the art for the '858 and '819 patents respectively.

II. Personal Background

6. I will briefly summarize my relevant education and work experience below. My qualifications are set forth in more detail in my updated curriculum vitae, a true and correct copy of which is attached as Exhibit 1 to my declaration.

7. I received my Bachelor of Science degree in Electrical Engineering with Highest Honors in 1966, my Master of Science degree in Electrical Engineering in 1967, and my Ph.D. in Electrical Engineering in 1969, all from the University of Tennessee, Knoxville.

8. After completing my education, I worked for thirty years in research and development at Bell Laboratories. During this time, I acquired significant expertise in several areas of telecommunication science and technology. My early work at Bell Laboratories, up until 1979, involved research related to microwave propagation and satellite communication systems. For the next four years, my work focused on digital signal processing, namely developing various improvements to reduce distortion in digital radio systems.

9. In 1985, I began working on development of voice-data enterprise networking via intelligent multiplexers. Specifically, I proposed the development of an "Intelligent T1 multiplexer" family of nodal processors, in addition to a subrate access multiplexer based on ISDN BRI (Integrated Services Digital Network Basic Rate Interface) line technology.

10. From 1989 through 1993, I worked on feature definition and coordination for SONET (Synchronous Optical Network) and ATM (Asynchronous Transfer Mode) products. I headed a team chartered with preparing a tier-2 system engineering specification for an intelligent synchronous multiplexer. This work led directly to development of Bell Laboratories' highly successful DDM-2000 OC-3/OC-12 SONET multiplexer.

11. In 1993 and 1994, I created and worked with an interdisciplinary Video-on-Demand team. With this team, I worked to define the end-to-end network architecture and identify technical issues associated with delivering MPEG Transport Streams across an ATM core network with CATV (cable television) access.

12. After completing this project, I worked until 1997 as a founding contributor of a Lucent Technologies program to develop and promote a standards specification for medium-access control and physical-layer technique for bi-directional delivery of digital multimedia services over CATV networks.

13. Finally, until I left Bell Laboratories in April 2001, I worked within Bell Laboratories Advanced Technologies to coordinate and monitor global wireless standards activities. There I provided input to strategic planning for wireless IP and mobile data networking, and oversaw prominent standards groups and numerous personnel, with an emphasis on 3GPP, 3GPP2, and IETF.

14. After leaving Bell Laboratories, from April 2001 into April 2004, I served as Chief Technology Officer at Cetacean Networks, Inc. There, I managed a technology group engaged in developing a novel IP protocol and system architecture, and advancing the science of temporally scheduled networks.

15. In 2004, I founded Enginnovation, LLC, an independent consulting firm. As principal of that firm, I am qualified to work on topics regarding packet networks, real-time IP applications requirements, transport system architectures, and wireless networks and architecture.

16. In June 2005, I became employed as Director of Technology for Rivulet Communications, Inc. In January 2006, I became Rivulet's Chief Technology Officer. In my capacity as CTO, I am responsible for furthering technology related to time-based resource reservation for Internet Protocol (IP) networks, and related management tasks, all in connection with traditional routing/switching and time-based routing techniques for voice-over-IP, video-over-IP, and circuit emulation services-over-IP.

17. Over the course of my career, I have authored nearly 70 refereed journal and conference publications, and contributed to three communications reference books. Some of the technology I invented or helped to develop is reflected in eight U.S. patents on which I am listed as an inventor.

18. In addition to my employment experience described above, I have had extensive

service as an officer of the IEEE Communications Society. From 2004 to 2005, I served as President of the IEEE Communications Society. Prior to my term as President, I also served on four IEEE editorial boards, and served two terms as a Director and two terms as a Vice-President of the IEEE Communications Society. I am currently immediate past president of the society, and serving as Division III Director-elect of the IEEE.

III. Materials Reviewed and Relied Upon

19. In connection with my work on this matter and in forming the opinions expressed in this declaration, I have reviewed and relied upon the following materials: (1) the '858 and '819 patents-in-suit and their respective prosecution histories, including the prior art cited therein; (2) the parties' Joint Claim Construction Statement (in both original and amended form), including the extrinsic evidence cited therein; (3) Rembrandt's opening claim construction brief and the papers submitted in support thereof, including the declaration of Dr. V. Thomas Rhyne; and (4) the deposition transcript of Dr. Rhyne.

IV. The '858 Patent

A. Technical overview and background of the '858 patent

20. The '858 patent generally relates to an architecture for a communications system. The particular communications equipment disclosed in the '858 patent, which the patent calls a "network access unit" (or NAU), interfaces with an outside network and transmits data to the network via "channelized" access—that is, various pieces of data are transmitted in different logical channels in the data stream going to the network—through the "network access module" (or NAM) component internal to the NAU. The invention of the '858 patent is premised on several concepts that I will explain below—first, multiple devices using the same medium for transmitting data; second, synchronous and packet data transmission; and, third, managing access to the transmission medium by multiple packet sources.

- **Multiple data sources sharing a common transmission medium**

21. The NAU of the '858 patent incorporates multiple data sources that share a common transmission medium, or "bus." This transmission medium pipelines the data from the various local sources to the NAM, which essentially acts as a gateway and in turn transmits the

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 7 of 15

data to the external network. The transmission medium has a given "bandwidth" or capacity for transferring data. The same transmission medium may be used by multiple data sources by dividing the bandwidth of the medium into discrete, repeating periods of time and allocating the periods for data transmission by the various sources. At the highest level, the '858 patent describes dividing the bandwidth of the bus into two repeating portions: one portion for the transmission by what the patent refers to as "packet" data sources; and the other portion for the transmission by what the patent refers to "synchronous" data sources, which I will discuss in further detail below.

22. One instance of the repeating portions corresponds to a "frame" as shown in Figure 5 of the patent. There is a repeated schedule or cycling of frames and of the time slots within the frame. Thus, for any given number of frames, in every cycle the same portion of the frame is allocated to packet data sources, and the same portion is allocated to synchronous data sources. And each portion is further divided into a number of time slots.

- **Packet and synchronous data transmission**

23. The '858 patent describes two different kinds of data transmission—synchronous data transmission (as would be used for voice telephony) and packet data transmission. Historically, voice telephony has used a format called "T1 multiplexing" to combine multiple voice conversations on a single "T1 facility." In a standard telephone system, for example, the line connecting groups of telephones to a central office is "time-division multiplexed." That is, the line is divided into frames and each frame is divided into a number of time slots (typically 24). Any particular time slot in a frame—for example slot number 10—might be associated with one and only one telephone (say telephone 18) on that node of the phone network. The frames repeat on a regular, periodic basis, so that time slot 10 arises repeatedly, once every time period of the frame. Every time that time slot 10 arises, telephone 18 is able to place a digital sample of its message on the network phone line. And at the receiving end, the receiver knows that all messages in time slot 10 come from telephone 18. The telephony data in each of the time slots "owns" the same time slot in each frame for the duration of the call. The telephony time slot repeats at precise intervals and is of a constant size and is said to be "synchronous," which refers

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 8 of 15

to a mode of transmission in which the sending and receiving equipment are operating continuously at the same rate and are maintained in a desired phase relationship. In this scenario, the sending and receiving equipment are in a "synchronous" relationship.

24. Historically, "packet" data networks carried computer data in packets where the sender did not "own" a particular time slot but was provided use of the network as needed or *a*synchronously. Each packet carried an address that described the destination of the packet much like the address on a letter describes the destination of the letter. Most computer data is referred to as variable bit-rate data, which means that the modes of transmission between the sending and receiving equipment do not need to operate in a synchronous manner. Variable bit-rate transmission commonly occurs in "packet" networks, in which the sending equipment formats and transmits information in data "packets" consisting of binary digits including address headers and other control elements. The packets are switched or routed according to the packet addresses, and then the receiving equipment pieces together transmitted data from any number of aggregate packets received from the sending equipment.

25. Telephony data is typically transmitted at a constant bit rate.[1] Constant bit-rate data, however, is not necessarily synchronous. For example, the '858 patent also describes an embodiment employing ATM (Asynchronous Transfer Mode), which is characterized by the use of small, constant-sized packets called cells. ATM cells or packets can carry both constant bit-rate data (as used for telephony) and variable bit-rate data. Telephony data transmitted in ATM packets is not exactly synchronous because of the asynchronous nature of the ATM packets, but ATM can support telephony because the data is transmitted, on average, at a constant bit rate.

- **Managing access to the transmission medium by multiple packet sources**

26. The invention of the '858 patent is premised on a system in which a portion of the TDM bus bandwidth is allocated for the transmission of packet data, and a different portion of the bus bandwidth is allocated for the transmission of synchronous data. The '858 patent refers to the portion of the bandwidth allocated for packet data transmission as the "multiple access

[1] Per Newton's Telecom Dictionary (7th edition, 1994) which Rembrandt submitted, constant bit rate (or CBR) "refers to processes such as voice that require a constant, repetitive or uniform

packet channel"(MAPC)—in other words, the channel (within the frame) that is shared by multiple packet data sources.

27. Each multiple access packet channel requires a mechanism by which transmission of data by the packet data sources is managed. The key feature of the '858 invention is the provision of a packet-manager mechanism "distributed" across and within each packet data source that replaces and obviates the need for the central manager.

28. The '858 describes prior-art NAUs that support both packet and synchronous data transmission. Within the NAU, various packet and synchronous data sources share a TDM bus. According to the '858 patent, the prior art suffered from limitations in the ability to accommodate high peak rates of packet data transmission. The prior art also required a "central" packet manager to allocate a fixed amount of bus bandwidth to each packet data source, which increased in complexity depending how many packet data sources were to be supported and their respective data rates. The prior-art central packet manager was responsible for assigning individual packet data sources their individual time slots allocated for transmission of packet data. The central packet manager could thereby insure that only a packet from one packet data source is inserted in the allocated slots at any given time.

29. The '858 invention improves upon the prior art with respect to packet data transmission by establishing a portion of the TDM bus bandwidth as the "multiple-access packet channel" (MAPC). In this MAPC portion, instead of having dedicated time slots to transmit their packet data, the packet data sources share and contend for the entire bandwidth allocated to packet data—*i.e.*, the entire MAPC portion. The '858 invention eliminates the need for a central packet manager by implementing a "distributed" packet-manager mechanism within each packet data source that allocates the MAPC among packet data sources. This distributed packet manager implements a mechanism by which each packet data source has an "access window" of time in which it and only it can capture and hold on to the MAPC (portion of the bus bandwidth allocated for transmitting packet data). In that way, the distributed packet manager performs the central packet manager function of insuring that a packet from only one packet data source is

---

transfer of information."

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 10 of 15

inserted in the allocated slots at any given time. When that packet data source completes its transmission, it relinquishes the bus, which the next packet data source can then capture. In this manner, the distributed packet manager mechanism avoids collisions between packet data sources attempting to transmit at the same time.

B. Disputed claim terms from the '858 patent

30. For purposes of the '858 patent, I have been asked to consider the parties' respective proposals for the claim term "time-division multiplexed bus" ("TDM bus"). Comcast's proposed construction, "a group of one or more conductors that is shared among several users by allowing each user to use the bus for a given period of time in a defined, repeated sequence," comports with the manner in which the patent describes the TDM bus. As depicted in Figure 5 of the patent and the corresponding text, successive frames (Frames 1-4) are time-divided into two portions consisting of a number of channels. One portion of each TDM frame represents the MPAC allocated for packet data transmission. The other portion corresponds to "Other TDM Channels" that are allocated for synchronous data transmission. This division of the TDM frame into a packet portion and a synchronous portion is repeated from frame to frame. Thus, there is a defined, repeated sequence over successive frames, in which a fixed and consistent portion of the TDM frame is allocated to packet data, and a fixed portion allocated to synchronous data.

31. Rembrandt's proposal, which does not mention that the discrete time interval must be defined, is problematic because it literally covers any bus in which one source transmits at one time, and another source transmits at another time. In my opinion, one of ordinary skill in the art would not consider this to be a TDM bus. A TDM bus requires that the transmission sequence be defined so that the receiving equipment can use that defined sequence in order to de-multiplex the transmitted, multiplexed data. Without a defined sequence, the receivers would be unable to determine what the data was or where it came from, and the data cannot be de-multiplexed at the receiving end.

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 11 of 15

V. The '819 Patent

A. Technical overview and background of the '819 patent

32. The '819 patent is concerned with the architecture of the network, including matters such as what devices are connected to the network and how each of them can communicate with one another.

33. The '819 patent describes a network that has a "master unit" communicating with a number of "remote units" over a "multidrop" network. Each of the remote units may run one or more applications that need to communicate with the master unit. In order to allow the remote units to communicate with the master without interfering either with other applications on that remote that need to communicate with the master, or with applications on other remotes communicating with the master over the same network media, the '819 patent provides for each application on a remote unit to have a "time slot" for transmitting to the master. Thus, during that assigned time slot, one and only one application can use the multidrop network, and the master unit will know, based upon the time slot assignment, which application on which remote unit is sending a message.

34. The '819 patent also provides for ranging, a process that adjusts the timing of transmissions to the master to take into account the short, but still important, time that it takes a message to travel from remote to master.

35. According to the inventor on the '819 patent, Joseph King, the invention came about in the late 1980s in an attempt to overcome some problems that Paradyne (his employer) had been experiencing with a modem product under development. Using Paradyne's then-extant product, a customer (such as Federal Express) would have branch offices with one or more computers running several different types of application programs. These programs might include, for example, inventory management programs, sales programs, or payroll programs. Each such program might need to communicate with a server at the master unit.

36. One of the benefits of Paradyne's product was that it used only a single network, a multidrop network that was able to service all applications. The alternative would have been using multiple multidrop networks, one for each application. That would have been more

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 12 of 15

expensive, but simpler to implement, as I explain below.

37. Because the single multidrop network served multiple applications, both the master and the remotes needed a mechanism by which they could determine what application a particular message related to so that it could be directed appropriately. In one approach, messages from different applications could be distinguished by using a different frequency for each application's message. Thus, the sales application would transmit using one frequency, while the inventory application would transmit using another. This method of using different frequencies on one network is known as "frequency division multiplexing." The problem, as described in the patent, is that the different frequency signals sharing the same physical medium can interfere with one another, which causes distortion and sometimes actual disruption of the communication. Mr. King's solution to this problem was to avoid frequency division multiplexing and instead rely upon time division multiple access on the multidrop network to permit multiple applications at each remote location to communicate with the master.

38. A common way for devices on a network to share the same medium is to divide the medium into discrete time periods. By dividing the discrete time period into "time slots," a communications system can provide for different uses for each time slot. The '819 patent describes a method whereby a group of time slots, referred to as a subframe, is assigned to each remote, and then within a subframe, each application using the remote unit for communicating with the master unit is assigned a time slot. Figure 5 of the '819 patent shows a typical subframe. As indicated there, the subframe is divided into "N" time slots, which are shown in Figure 5 as corresponding to each different application.

39. The time slot assignment process occurs upon initialization, and is explained generally as follows:

> The time division multiple access sequence is established by the user. An epoch period or frame is defined by the user. The frame is divided with respect to time into a number of subframes. The subframe is further subdivided into slots, one for each application. Therefore, an application has a preassigned time period (or slot) within a subframe to transmit from the remote unit to the master unit, with the possibility of a reservation request for longer messages.

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 13 of 15

'819 at 4:53-61.

40. The invention Mr. King developed also utilizes a process known as "ranging." Ranging is the process of measuring the delay a signal experiences in traveling from the master unit to the remote unit and back to the master unit. This is like the ranging performed by a submarine when it "pings" a distant object. The pinging sound takes longer to return from objects further from the submarine. For submarines the delay time is converted to a distance value called the range. In the '819 patent, after the master unit has "pinged" a combination of remote unit and application, the master unit sends the delay time value to the remote unit. The ranging delay time value is used in the remote unit of the '819 patent to allow the remote unit to adjust its transmission time to optimize the time of arrival of the signal at the master unit and thereby minimizes wasted "guard time" that must separate one transmission from the next in this time division multiple access system.

B. Disputed claim terms from the '819 patent

- **"application program"**

41. In my opinion, in the September 1988 time frame (around the filing date of the application for the '819 patent), a person of ordinary skill in the art would have understood the term "application program" to have a generally accepted meaning—namely, software-implemented functionality for a specific end-user task, which is distinct from "utility" programs that implement system management, monitoring, or maintenance functionality.

42. Comcast's construction comports with this understanding. On the other hand, Rembrandt's proposed construction—"a computer program or process"—is overly broad and fails to distinguish between, and captures both, applications and utilities.

- **"master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said application programs in said one of said remote units is assigned to transmit to said master unit in a time division multiple access fashion"**

43. In my opinion, a person of ordinary skill in the art would not consider the "master network timing means ..." claim term to be the name for any particular structure, or to have any well understood meaning in the art. Further, by itself this claim term fails to connote any

Case 2:05-cv-00443-TJW-CE Document 123-1 Filed 01/10/2007 Page 14 of 15

structure and instead only recites functionality—namely, dividing a period into subframes and each subframe further into time slots, and assigning a time slot to each application program. A person of ordinary skill in the art would not be able to determine what structure was intended to carry out this functionality based on the claim language alone. Instead, one would have to resort to the patent specification to determine what structures are disclosed for carrying out this functionality.

44. The patent specification discloses the following structure corresponding to function performed by the "master network timing means …": network timing control processor 12 running software that implements an algorithm in which there is a fixed, one-to-one assignment between each subframe and each remote unit; and between each time slot and each application program. *See, e.g.*, '819 at 2:5-7, 2:25-27, 2:61-3:6, 4:55-61, 5:14-23, 5:46-56, Fig. 5. Each of these disclosed structural components is necessary for performing the function of dividing a period into subframes and each subframe further into time slots, and assigning a time slot to each application program. Indeed, processor 12 running software is the only structure disclosed in the patent specification for this function.

- **"ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units"**

45. As with the "master network timing means …" claim term above, a person of ordinary skill in the art would not consider the "ranging means …" claim term to be the name for any particular structure, or to have any reasonably well understood meaning in the art. Further, "ranging means …" fails to connote any structure and only recites functionality—namely, calculating and transmitting to each remote unit the time it takes to transmit between the master unit and that remote unit. A person of ordinary skill in the art would not be able to determine what structure was intended to carry out this function based on the claim language alone. Instead, one would have to resort to the patent specification to determine what structures are disclosed for carrying out this function.

46. In my opinion, among the various structures that the '819 patent specification

discloses as corresponding to the ranging means, at least the following are necessary for performing the function of calculating and transmitting to each remote unit the time it takes to transmit between the master unit and that remote unit: network timing and control processor 12, ranging and network initialization generator 20, and ranging receiver 32.

C. Mischaracterizations of my deposition testimony

47. I understand that Rembrandt claims in its briefing that I "agreed that the '858 [sic, '819] patent describes assigning time slots dynamically." That is incorrect. As I stated immediately thereafter, "the master unit is going to make a decision as to whether or not the requesting remote unit should use additional access slots. It doesn't say they are allocated to them." Thus, the process that is described in the '819 patent does not allow the assignment of time slots to other remote units in a dynamic fashion. Rather, it permits remote units to request permission to, and upon receiving permission, utilize, the time slots assigned to other remote units.

48. I further understand the Rembrandt claims in its briefing that I "testified that ... priority could be assigned on an application by application basis." That too is false. I simply agreed that Figure 5 of the '819 patent shows that priority bits may be associated with an application. That does nothing to detract from the clear statements in the specification that priority is determined on a remote-by-remote basis, rather than by particular applications. *See, e.g.*, '819 at 2:22-24, 7:2-3.

I swear under penalty of perjury under the laws of the United States that the foregoing statements are true and correct, and that I executed this declaration on January 10, 2007, at Andover, Massachusetts.

By: Curtis A Siller, Jr.
Curtis A. Siller, Jr., Ph.D.

EXHIBIT 1A
OF
DECLARATION
OF
CURTIS A. SILLER, JR., PH.D.

Case 2:05-cv-00443-TJW-CE Document 123-2 Filed 01/10/2007 Page 2 of 4

Abbreviated Curriculum Vitae

Dr. CURTIS A. SILLER, Jr.

3 Wintergreen Circle
Andover, Massachusetts 01810-3216 USA
T: +1 978.687.9586
E-mail: ca0404s@yahoo.com

MOST RECENT POSITIONS

Rivulet Communications, Inc.: 2005 – Present

Currently Chief Technology Officer – Provides corporate direction in relation to time-based resource reservation for Internet Protocol (IP) networks. Responsible for: furthering the technology; supporting marketing and sales development initiatives; delivering conference presentations and authoring archival publications; and developing the company's intellectual property portfolio, all in relation to traditional routing/switching and time-based routing techniques for voice-over-IP, video-over-IP, and circuit emulation services-over-IP.

Enginnovation, LLC: 2004 – Present

Founder and principal of an independent consulting firm. Areas of expertise include: Packet networks, real-time IP applications requirements, transport system architectures (e.g., Cable TV, SONET and SDH), wireless networks and architectures. Prepare white papers and sales materials, and offer Expert Opinions regarding patent infringement and litigation.

Cetacean Networks, Inc.: 2001 – 2004

Chief Technology Officer - Managed the technology group and contributed to the work of a highly motivated start-up engaged in developing a novel IP protocol and system architecture. Experience there was related to: advancing the science of temporally scheduled networks; developing sales and marketing materials; interfacing with corporate engineering and development teams; providing technical sales support; and preparing sale's and investors' presentations. Personally responsible for fostering and managing the company's intellectual property (e.g., patents, trademarks).

Accomplishments: Managed a highly productive group; significantly advanced the science of IP networks by publishing several scholarly, refereed papers; wrote numerous white papers; developed sales collateral; participated in numerous VC presentations; direct interface with Engineering and Development organizations; facilitated filing of numerous patent applications; successfully argued the claims and improved the breadth of others, while arguing EPO claims. (This company ceased to operate in April 2004.)

PRIOR CAREER – SYNOPSIS (1969-2001)

Extensive R&D experience (over 36 years, 30 with Bell Laboratories) in the areas of:

- Extensive standards experience: Articulated internal strategy and coordinated *all* Bell Labs standards activities in wireless voice and mobile data networking; active participant in IEEE 802.14 (secondarily, .1 and .3), IETF, ATM Forum;
- Systems engineering for digital service delivery via packet networks – MPEG over ATM for Video-on-Demand; H.323 VoIP gateways into ATM core networks; VoDSL; TDM, IP and STM protocols for network access in CATV plants;
- Conceived communications transport products, e.g., dataports for D-channel banks, enterprise network "intelligent" multiplexers, and SONET/SDH optical access transmission equipment (e.g., Lucent DDM-2000 OC-3/12); coordinated cross-organizational release of SONET/SDH product features;
- Digital signal processing, especially high speed digital filters and adaptive equalizers for multilevel QAM radio systems

Case 2:05-cv-00443-TJW-CE Document 123-2 Filed 01/10/2007 Page 3 of 4

- Microwave propagation; exploratory antenna studies for terrestrial and radio astronomy applications; and interference analysis and suppression for point-to-point FM and satellite communication systems.

A complete description of these activities follows. Please see "DETAILED Bell Labs EXPERIENCE"

PROFESSIONAL SKILLS

Exceptionally wide breadth of professional/technical experience; outstanding written and presentation abilities; adept at pulling together multi-organizational *ad hoc* teams to rapidly address complex technical issues or establish strategic directions; extensive contacts in all segments of the communications industry; and excellent interpersonal skills.

MAJOR CAREER MILESTONES (Professional recognition, accomplishments, etc.)

- President, IEEE Communications Society, 2004 – 2005. Currently immediate past president.
  - ✓ Two Vice-presidential and two Director terms; served on four editorial boards
- Bell Laboratories Fellow (1989)
- IEEE Fellow (1992)
- Editor-in-Chief, *IEEE Communications Magazine* (1993-1995)
- Co-editor and contributor to SONET/SDH: A Sourcebook of Synchronous Networking (IEEE Press, 1996)
- AT&T Technologies Engineering Excellence Award (1996)
- IEEE Communications Society David W. McLellan Meritorious Service Award, (1997)
- Bell Laboratories Advanced Technology Excellence Award (1998)
- IEEE Communications Society Publications Exemplary Service Award
- IEEE Third Millennium Medal (2000)
- Other: authored nearly 70 refereed journal/conference publications, including significant international presentations; awarded eight patents; contributed to three (additional) communications reference books; served in administrative capacity for nearly 40 major technical symposia

EDUCATION

- B.S. (Electrical Engineering, Highest Honors, 1966), M.S. in Electrical Engineering (Plasma Physics, 1967) and Ph.D. in Electrical Engineering (Electromagnetic Theory, 1969), The University of Tennessee - Knoxville
  - Honor Societies: Phi Eta Sigma, Eta Kappa Nu, Phi Kappa Phi, Tau Beta Pi, and Sigma Xi
  - Profiled in February 2004 *Tennessee Alumnus* magazine

DETAILED Bell Labs EXPERIENCE

Standards Participation and Corporate Strategy Development, 1997 – 2001
Worked within Bell Labs Advanced Technologies (BL-AT) to: coordinate and monitor global wireless standards activities and provide input to strategic planning for wireless IP and mobile data networking. This activity encompassed oversight of prominent standards groups, numerous personnel, with a technical emphasis on 3GPP, 3GPP2 and IETF.

Previously served as Lucent Delegation Manager to:

- The ATM Forum (ATMF) Voice and Multimedia Over ATM (VMOA) Working Group (cited contributor to VODSL specification AF-VMOA-0145.000, "Loop Emulation Service Using AAL2", July 2000); and
- Real-time Multimedia Over ATM Working Group (cited contributor to specification AF-SAA-0124.000, "Gateway for H.323 Media Transport Over ATM", July 1999).

Participated in the ATM Forum Residential Broadband (RBB) Working Group and facilitated Lucent's internal standards strategy relating to label switching, leading up to work in the IETF Multiprotocol Label Switching (MPLS) Working Group.

Medium Access Control and Physical Layer Specification for Digital Services on Cable Networks, 1994 – 1997
Among founding contributors to a Lucent program to conceive and promote standards specification for a medium-access control/physical-layer technique for bi-directional delivery of STM-, ATM- and IP-based digital multimedia services over CATV networks. Served as Lucent Delegation Manager in IEEE 802.14 standards group. This control protocol, known as ADAPt+, resulted in 4 patents, 6 peer-reviewed papers, and is the basis for Chapter 7 in: U. Black. *Residential Broadband Networks* (Saddle River, NJ: Prentice Hall, 1998).

ATM/MPEG Video-on-Demand Service Delivery Architectures, 1993 – 1994
Created an interdisciplinary Video-on-Demand (VOD) *ad hoc* team to define the end-to-end network architecture and identify technical issues associated with delivering MPEG Transport Streams across an ATM core network with CATV access. This work elucidated the effects of ATM/MPEG-II interworking on jitter and Program Clock recovery, and influenced subsequent international specification of an AAL for video services. Edited and contributed to a comprehensive team report that was handed off to Bell Labs' set-top terminal development organization as a preliminary System Requirements Document (SRD).

Feature Definition and Coordination for SONET and ATM Products, 1989 – 1993
Formed and directed a five-member team chartered with preparing a tier-2 system engineering specification for an intelligent synchronous multiplexer. The team studied customer RFPs, assessed internal technologies and sized the market in the course of preparing a final report for VP review in less than five months. This work directly lead to the development of Bell Lab's highly successful DDM-2000 OC-3/OC-12 SONET multiplexer. Subsequently lead a review program to identify features, propose feature coordination, assure timeliness to market, and trace central office evolution for the company's *family* of SONET transmission products: digital loop carrier, access multiplexer, cross-connect, and lightwave equipment. Also lead Bell Labs transmission team in responding to European RFPs for ATM broadband cross-connects. The resulting architectural work was used as a basis for ATM cross-connect and switch product development.

Voice-Data Enterprise Networking via Intelligent Multiplexers, 1985 – 1989
Proposed development of an "Intelligent T1 multiplexer" family of nodal processors, in addition to a subrate access multiplexer based on ISDN BRI line technology, for enterprise networks. Created and lead a corporate-wide team of technologists, product managers, and customer sales specialists in preparing a comprehensive report that specified features, development resources and timeline, distribution channels, market size and strategy, along with implications for the company's existing central office channel bank equipment. Over $30M spent on product development.

Digital Signal Processing, 1980 – 1984
Identified the applicability of adaptive transversal equalizer modem technology to multipath distortion in high-speed m-QAM digital radio systems. Worked with a development group to realize the world's first such equalizer. Extended concept of the zero-forcing algorithm in T-spaced equalizers for use in fractionally spaced (T/2) equalizers, as a means for eliminating coefficient drift. Worked closely with other technical staff as co-inventor of an approach for designing all-digital half-Nyquist baseband receiver filters, with extensions to cross-rail postdistortion in passband QAM systems. Co-inventor of a passband QAM noise-canceller/interference-equalizer. Published 21 articles on this work; awarded four patents.

Microwave Propagation, 1970 – 1979
Served for much of this time as the sole analyst in a research group charged with: improving the far-field radiation pattern of widely deployed pyramidal horn-reflector antennas; providing analytic support in the proposal of a novel radio astronomy antenna; proposing and assessing antenna designs for new digital radio systems; and identifying means to reduce electromagnetic interference, which hampered antenna deployment in urban areas. Provided the analytic framework for the first assessment of ground-based radiation from terrestrial antennas on satellite communication systems. This period of work resulted in 9 published papers.

SEALED

DOCUMENT

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP **v.** **COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP**	**Civil Action No. 2:05-cv-00443-TJW** **Jury Trial Demanded**

NOTICE OF SUPPLEMENTAL AUTHORITY

Rembrandt files this Notice to provide the Court with a recently issued opinion relevant to Time Warner's Motion to Disqualify (Dkt. No. 78) and Rembrandt's Response in Opposition thereto (Dkt. No. 83). This decision was not available to the parties at the time of briefing. The briefing schedule for the motion to disqualify has ended. Accordingly, Rembrandt offers no argument on this new opinion. If the Court requires further briefing, Rembrandt will be happy to provide same. The opinion in question, *Enzo Biochem, Inc. et al vs. Applera Corp., et al, No. 3:04cv929* (D. Conn.) is attached as Exhibit A.

Respectfully submitted,

PARKER, BUNT & AINSWORTH, P.C.

/s/ *Robert Christopher Bunt*
Robert Christopher Bunt
State Bar No. 00787165
Robert M. Parker
State Bar No. 15498000
PARKER, BUNT & AINSWORTH, P.C.
100 E. Ferguson, Suite 1114
Tyler, Texas 75702
Tel: 903-531-3535
Fax: 903-533-9687
E-mail: rcbunt@pbatyler.com
E-mail: rmparker@pbatyler.com

CERTIFICATE OF SERVICE

I hereby certify that the all counsel of record, who are deemed to have consented to electronic service are being served this 12th day of January, 2007, with a copy of this document via certified mail.

/s/ *Robert Christopher Bunt*
Robert Christopher Bunt

UNITED STATES DISTRICT COURT
DISTRICT OF CONNECTICUT

ENZO BIOCHEM, INC. ET AL.,	:	
Plaintiffs,	:	
	:	**No. 3:04cv929 (JBA)**
v.	:	
	:	
APPLERA CORP. ET AL.,	:	
Defendants.	:	

RULING AND ORDER ON GENERAL ELECTRIC'S MOTION TO INTERVENE FOR LIMITED PURPOSE AND MOTION TO DISQUALIFY PLAINTIFF'S COUNSEL [DOC. #121]

On May 23, 2006, General Electric ("GE") moved to intervene in this action pursuant to Fed. R. Civ. P. 24 for the limited purpose of seeking to disqualify plaintiffs' counsel, Hunton & Williams LLP ("Hunton"). As GE is only moving to intervene in this case for the limited purpose of filing its motion to disqualify plaintiff's counsel, and GE has a demonstrated interest in ensuring that Hunton's representation of Enzo in this action does not compromise its attorney-client relationship with Hunton, the Court grants GE's motion to intervene pursuant to Fed. R. Civ. P. 24(a) in order to consider its motion to disqualify. See, e.g., Oxford Systems, Inc. v. CellPro, Inc., 45 F. Supp. 2d 1055, 1058 (W.D. Wash. 1999); GATX/Airlog Co. v. Evergreen Int'l Airlines, Inc., 8 F. Supp. 2d 1182, 1188 (N.D. Cal. 1998).

GE claims that Hunton's representation of Enzo in this action is directly adverse to GE in violation of Rule 1.7(a) of

the Connecticut Rules of Professional Conduct. The issue before the Court is whether Hunton can represent a plaintiff in one case where the subject matter has significant overlap with that in another case in which that same plaintiff (represented by different counsel) is suing a client of Hunton's. The Court concludes based on the record before it that Hunton's disqualification is not warranted, and GE's motion to disqualify is therefore DENIED.

I. Factual and Procedural Background

Plaintiffs Enzo Biochem, Inc. and Enzo Life Sciences, Inc. (collectively "Enzo"), and Yale University ("Yale") filed suit against defendants Applera Corp. ("Applera") and Tropix Inc. ("Tropix") on June 7, 2004, claiming patent infringement under 35 U.S.C. §§ 271, et seq. (See Compl. [Doc. #1] at 1.) Six patents concerning techniques and processes for the detection of nucleic acids are the subject of the case: U.S. Patent Nos. 5,476,928 ("Ward '928 Patent"), 5,449,767 ("Ward '767 Patent"), 5,328,824 ("Ward '824 Patent"), 4,711,955 ("Ward '955 Patent"), 5,082,830 ("Brakel Patent"), and 4,994,373 ("Stavrianopoulos Patent"). (See id. at 1-2.) The Court issued its Claim Construction Ruling on the disputed claims and terms of these patents on October 13, 2006. (See [Doc. #137].)

On July 17, 2006, a claim construction ruling covering some of the same terms and claims of these patents was issued in Enzo

Biochem, Inc., et al. v. Amersham PLC, et al., 439 F. Supp. 2d 309 (S.D.N.Y. 2006). Due to some divergent constructions by the two courts, this Court certified Applera for interlocutory appeal to the Federal Circuit pursuant to 28 U.S.C. 1292(b) [Doc. #137]. The Federal Circuit denied both Enzo's and Applera's petitions for permission to bring this interlocutory appeal on November 27, 2006.

The Amersham action was commenced on October 23, 2002 (GE Mot. [Doc. #121] at 2-3). In October 2003, GE announced its acquisition of Amersham, which was finalized April 8, 2004. (See GE Mot. at 3.) Also in October 2003, Enzo retained Hunton to prepare the Applera action, which was filed in June 2004.[1] (See Fedus Aff., Pls. Ex. 6, ¶ 3.) Enzo retained Greenberg Traurig LLP ("Greenberg") in the Amersham action in mid-2004. (See Fedus Aff., Pls. Ex. 6 [Doc. #127-16], ¶ 2.)

According to GE, it is "a long-standing client" of Hunton's — the division GE Healthcare has been a client of Hunton's since November 14, 2001 (Schulman Aff., Pls. Ex. 3 [Doc. #127-5], ¶ 3) — and Hunton "continues to represent GE on various matters, including intellectual property matters." (GE Mot. at 3.)

In July 2005, Hunton associates Jeffrey Perez and David

---

[1] Ronald C. Fedus, Enzo's Corporation and Patent Counsel, represents that "since at least 2001, Hunton has advised Enzo with repect to its patent and interference rights vis-a-vis Applera." (Fedus Aff., Pls. Ex. 6 ¶ 3.)

Kelly, and Hunton partner Scott Robertson attended the Markman hearing in Amersham. (See Pls. Opp. Mem. [Doc. #127-2] at 7; Robertson Aff., Pls. Ex. 7 [Doc. #127-17], ¶ 10.) On August 4, 2005, at a deposition of inventor Dr. David C. Ward in Amersham, Hunton lawyer Jeffrey Perez was in attendance and "appeared" "for Biochem, Inc." (Ward Dep. Tr., GE Ex. I-A [Doc. #121-2], at 579.) At the deposition, Amersham's counsel Jennifer A. Sklenar engaged in the following colloquy with Greenberg attorney Scott J. Bornstein and Yale's attorney Levina Wong after the witness was questioned about a conversation he had with Hunton attorney Perez regarding distribution agreements:

> Q (Mr. Ulmer, counsel for defendant Affymetrix). In the preparation session that you had for this deposition that Mr. Perez attended, did he say anything at the — in that session?
>
> A (Mr. Ward). No. Mr. Bornstein was the one who did the majority of the talking, . . .
>
> Q. But Mr. Perez did speak, right?
>
> A. Yes.
>
> Q. Do you recall anything that Mr. Perez said?
>
> Mr. Bornstein: You can answer that yes or no.
>
> The Witness: Yes.
>
> Q. (By Mr. Ulmer) What was that?
>
> Mr. Bornstein: (speaking to the witness) I'm going to direct you not to answer on the basis of the attorney-client privilege.
>
> . . .
>
> Ms. Sklenar: Just so we have it clear on the

> record, are you taking the position that for conversations that Hunton & Williams participates in that there is a privilege?
>
> Ms. Wong: Yes.
>
> . . .
>
> Mr Bornstein: I'm happy to tell you, as you know, that Hunton & Williams represents Enzo in connection with litigation.
>
> Ms. Wong: Hunton & Williams also represents Yale in connection with the Enzo litigation.

(Id. at 679-81.)

Based on Perez's appearance at that deposition, chief litigation counsel of GE Healthcare, Patrick Murphy, avers that he "immediately complained to Hunton's litigation chairman, Thomas Slater" by phone and email in July and August 2005. (Murphy Aff., GE Ex. II [Doc. #121-3], ¶ 6.) According to Murphy, "Slater assured me that this cross-over had been inadvertent and that Hunton would not participate in activities adverse to GE. Specifically, Hunton promised to maintain an ethical wall between the Connecticut action and the New York action." (Id.) Slater states that,

> On June 7, 2005, Pat Murphy of GE Healthcare called me to discuss Hunton & Williams' participation in the Enzo case. After talking to Murphy . . ., I communicated with my partner Scott Robertson, . . . [who] assured me that Hunton & Williams was not assisting the Greenberg lawyers in the Amersham case, but that we needed to talk to them on occasion in order to properly represent Enzo in the action against Applera in this Court.

(Slater Aff., Pls. Ex. 5 [Doc. #127-6], ¶ 4.) Slater represents: "I again contacted my partner Scott Robertson. I learned from

Case 1:05-cv-00439-SLR-CE Document 119 Filed 06/18/2007 Page 6 of 21

Robertson that to the extent that Jeff Perez had stated that he was appearing for Enzo in the New York Action, Perez had misspoken" (Slater Aff., Pls. Ex. 5, ¶ 6).

On August 31, 2005, Robert Schulman, Hunton IP partner in charge of GE Healthcare, wrote an email to Robertson, Slater, and others describing his conversation with Carl Horton, Chief Patent Counsel in GE Healthcare's legal department: Horton had discussed "Murphy's concerns with respect to our Enzo representation. . . . with [Murphy] . . . [and] as far as he can tell, [Murphy] is satisfied with the current arrangement." (Schulman Aug. 31, 2005 email, Pls. Ex. 3-A [Doc. #127-5].)

On March 31, 2006, a conference call was held among counsel in Amersham. During this call, according to Sklenar, Greenberg "stated that Enzo intended to seek leave from Judge Sprizzo to file in the New York cases a claim construction submission that Enzo was also filing in its case against Applera." (Sklenar Aff., GE Ex. I [Doc. #121-2], ¶ 3.) Sklenar notes that this claim construction document [Doc. #114] relating to a disputed term[2] "was filed on April 6, 2006, six days after [the] conference call" (Sklenar Aff., GE Ex. I, ¶¶ 3, 4). Robertson explains: "As a courtesy, . . . Hunton attorneys informed Greenberg that it would be submitting this supplemental briefing

---

[2] The chart concerns the "A" moiety in the '824 and '767 patents. (See Bornstein Letter, Pls. Ex. 8-A, at 2.)

Case 1:05-cv-00493-TGM-SE Document 112-8 Filed 06/12/2007 Page 7 of 21

in the Connecticut Action. Thereafter, Hunton attorneys learned that Greenberg intended to inform the Court in the New York Action of this supplemental briefing, and sought leave to submit the chart in that litigation."[3] (Robertson Aff., Pls. Ex. 7 [Doc. #127-17], ¶ 9.) According to Bornstein, Judge Sprizzo "declined to accept the supplemental chart" on May 12, 2006 (Bornstein Aff., Pls. Ex. 8 [Doc. #127-18], ¶ 10).

Also on April 6, 2006, Schulman wrote an email to Horton, copied to Robertson, Slater, and others at Hunton, stating that Hunton lawyers would "refrain from attending any hearings or depositions in the New York case" but "considered it proper to receive assistance from Greenberg counsel to help us in our Connecticut case;" and that because "we undertook the representation of Enzo in this case before GE acquired Amersham. . . . our representation does not create any 'ethical' conflict under the DC rules." (Schulman Apr. 6, 2006 email, Pls. Ex. 3-B [Doc. #127-5].) On April 16, 2006, Horton responded to Schulman: "GE's acquisition of Amersham was announced October 2003 and completed April 2004. Enzo sued Applera in June of 2004. Thus, I don't understand the 'thrust upon' argument unless Hunton is going to argue that it was preparing to file Enzo's case against

---

[3] Greenberg requested that the claim construction chart be admitted in an April 18, 2006 letter to Judge Sprizzo. (See Bornstein Letter, Pls. Ex. 8-A.)

Case 1:07-cv-04398-GW Document 19-2 Filed 06/28/2007 Page 8 of 21

Applera for more than 8 months." (Horton Apr. 16, 2006 5:55 a.m. email, Pls. Ex. 3-C [Doc. #127-5].) Horton also clarified that at the Ward deposition, "Hunton lawyer [Perez] announced on the record that he was appearing for Enzo, he conferred with the witness and the Greenberg lawyer during the breaks, and was involved in preparing the witness." (Id.) That same day, Schulman responded to Hunton, representing that, "I am certain that as of April '04, we were deeply into this case;" "please do not lose sight of the fact that our particular engagement is against Apelera [sic], not Amersham;" "none of the attorneys working for GE [Healthcare], myself included, is working on the litigation;" "As for the Ward deposition, I had been told by Jeff Perez that such had occurred in June and this information turned out to be inaccurate;" and "the date of the Ward deposition was Aug. 2-5, 2005 and the date of the internal communication at Hunton prohibiting further collaboration with Greenberg in their case was August 9, 2005." (Schulman Apr. 16, 2006 email, Pls. Ex. 3-C.) Finally, Horton responded again that same day, assuring Schulman, "just so you know, I have absolutely NO issue with this whole thing. . . . But, it is getting dicey." (Horton Apr. 16, 2006 6:45 p.m. email, Pls. Ex. 3-C.)

Then, according to Hunton's Slater, on April 27, 2006 Murphy and GE Vice President for Litigation and Legal Policy John Graham contacted Slater to inform him that GE planned to move for

disqualification. (Slater Aff., Pls. Ex. 5, ¶ 11.) Despite subsequent conversations and negotiations between GE and Hunton, GE filed the motions [Doc. #121] on May 23, 2006.

In a July 4, 2006 declaration, Horton expressed a changed perspective: "I have since learned that Hunton and Greenberg Traurig appear to be regularly discussing their respective positions on important issues such as claim construction. Such conduct is completely at odds with Hunton's representations to me of a strict ethical wall between the two cases." (Horton Aff., Pls. Reply Mem. Ex. [Doc. #131], ¶ 7.) He further stated, "I have concluded that Hunton's representation of Enzo in the Connecticut case has created an unavoidable conflict of interest with respect to its client, GE." (Id. ¶ 10.)

After this Court issued its Claim Construction Ruling on October 12, 2006, GE moved [Doc. #139] and was granted leave [Doc. #143] to file a supplemental brief [Doc. #140] in further support of its Motions, wherein GE argues that, "Should the Federal Circuit decide to hear the interlocutory appeal, Hunton will inevitably argue — indeed, it must argue — that many, if not most, of Judge Sprizzo's claim constructions were faulty. Thus, Hunton cannot avoid directly attacking a ruling favorable to its client, General Electric, in the New York case." (GE Supplem. Br. [Doc. #140] at 2.) Plaintiffs responded by stating that, "the Federal Circuit rarely exercises its jurisdiction to hear

Case 2:05-cv-00439-FJM-SCE Document 19-8 Filed 06/18/2007 Page 10 of 21

interlocutory appeals of such issues," and that even it if did, "Hunton's representation of Plaintiffs before the Federal Circuit would not rise to the level of direct adversity." (Pls. Br. in Opp. [Doc. #142] at 3.) The Federal Circuit has since declined to grant the parties permission to pursue the interlocutory appeal, and at oral argument, Hunton represented that it has decided it will not represent Enzo on any appeal in this case.

II. Legal Standard for Disqualification

"A district court has 'substantial latitude' to require disqualification." United States v. Zichettello, 208 F.3d 72, 104 (2d Cir. 2000) (citing Wheat v. United States, 486 U.S. 153, 163, (1988); United States v. Locascio, 6 F.3d 924, 931 (2d Cir. 1993)). A court's authority to disqualify an attorney "derives from [its] inherent power to preserve the integrity of the adversary process." Hempstead Video, Inc. v. Incorporated Village of Valley Stream, 409 F.3d 127, 132 (2d Cir. 2005) (internal quotation omitted). "In exercising this power, [courts] attempt[] to balance a client's right freely to choose his counsel against the need to maintain the highest standards of the profession." Id. The moving party bears "the heavy burden of proving facts required for disqualification," see Evans v. Artek Sys. Corp., 715 F.2d 788, 794 (2d Cir. 1983), and the Second Circuit has adopted "a restrained approach that focuses primarily on preserving the integrity of the trial," see

Armstrong v. McAlpin, 625 F.2d 433, 444 (2d Cir. 1980), vacated on other grounds, 449 U.S. 1106 (1981).

Accordingly, although courts' "decisions on disqualification motions often benefit from guidance offered by the American Bar Association (ABA) and state disciplinary rules . . . such rules merely provide general guidance and not every violation of a disciplinary rule will necessarily lead to disqualification." Hempstead Video, 409 F.3d at 132; accord United States Football League v. Nat'l Football League, 605 F. Supp. 1448, 1463 n.31 (S.D.N.Y. 1985) ("While the [Code of Professional Responsibility] is a source by which courts may be guided, it is not the final word on disqualification. Courts are not policemen of the legal profession; that is for the disciplinary arm of the bar. Disqualification is granted to protect the integrity of the proceedings, not to monitor the ethics of attorneys' conduct."). In the Second Circuit, "[r]ecognizing the serious impact of attorney disqualification on the client's right to select counsel of his choice, we have indicated that such relief should ordinarily be granted only when a violation of [professional rules of conduct] poses a significant risk of trial taint." Glueck v. Jonathan Logan, Inc., 653 F.2d 746, 748 (2d Cir. 1981) (citing Armstrong v. McAlpin, 625 F.2d 433, 444-46 (2d Cir. 1980) (en banc), vacated on other grounds and remanded, 449 U.S. 1106, 101 S. Ct. 911 (1981); Bd. of Educ. v. Nyquist, 590 F.2d 1241,

1246 (2d Cir. 1979)).

Finally, courts must balance three competing interests in deciding whether to disqualify counsel: "(1) the client's interest in freely selecting counsel of her choice, (2) the adversary's interest in the trial free from the risk of even inadvertent disclosures of confidential information, and (3) the public's interest in the scrupulous administration of justice." Hull v. Celanese Corp., 513 F.2d 568, 570 (2d Cir. 1975).

III. Discussion

A. Rule 1.7(a) and Concurrent Conflicts Generally

Rule 1.7(a) of the Connecticut Rules of Professional Conduct provides in relevant part:

> (a) Except as provided in subsection (b),[4] a

---

[4] Subsection (b) reads:

> (b) Notwithstanding the existence of a concurrent conflict of interest under subsection (a), a lawyer may represent a client if:
> (1) the lawyer reasonably believes that the lawyer will be able to provide competent and diligent representation to each affected client;
> (2) the representation is not prohibited by law;
> (3) the representation does not involve the assertion of a claim by one client against another client represented by the lawyer in the same litigation or the same proceeding before any tribunal; and
> (4) each affected client gives informed consent, confirmed in writing.

Conn. R. Prof'l Conduct 1.7(b). As the four requirements of this subsection are in the conjunctive, and there is no evidence presented that GE gave its informed, written consent to the asserted conflict (factor (4)), subsection (b) does not apply.

> lawyer shall not represent a client if the representation involves a concurrent conflict of interest. A concurrent conflict of interest exists if:
> (1) the representation of one client will be directly adverse to another client; . . .

The Commentary to the Rule says of the phrase "directly adverse" in subsection (a)(1):

> [A]bsent consent, a lawyer may not act as advocate in one matter against a person the lawyer represents in some other matter, even when the matters are wholly unrelated. . . . Similarly, a directly adverse conflict may arise when a lawyer is required to cross-examine a client who appears as a witness in a lawsuit involving another client, as when the testimony will be damaging to the client who is represented in the lawsuit.

Conn. R. Prof'l Conduct 1.7 cmt. Another section of the Commentary speaks to the issue of positional versus direct conflict:

> Ordinarily a lawyer may take inconsistent legal positions in different tribunals at different times on behalf of different clients. The mere fact that advocating a legal position on behalf of one client might create precedent adverse to the interests of a client represented by the lawyer in an unrelated matter does not create a conflict of interest. A conflict of interest exists, however, if there is a significant risk that a lawyer's action on behalf of one client will materially limit the lawyer's effectiveness in representing another client in a different case: for example, when a decision favoring one client will create a precedent likely to seriously weaken the position taken on behalf of the other client.

Conn. R. Prof'l Conduct 1.7 cmt.

The Restatement of The Law Governing Lawyers defines conflicts of interests as involving "a substantial risk that the

lawyer's representation of the client would be materially and adversely affected by the lawyer's . . . duties to another current client." Restatement (Third) of The Law Governing Lawyers § 121 (2000). It advises: "General antagonism between clients does not necessarily mean that a lawyer would be engaged in conflicted representations by representing the clients in separate, unrelated matters." Id. cmt. c. Moreover, a conflict is only prohibited where a lawyer's "activities materially and adversely affect the lawyer's ability to represent a client including such an effect on a client's reasonable expectation of the lawyer's loyalty." Id. cmt. d.

B. Circumstances of Conflict and Duty of Loyalty

Relying on Rule 1.7(a)(1), GE argues that Hunton's representation of Enzo is "directly adverse" to GE's interests in that:

> (i) Hunton appeared adverse to GE during depositions in the New York action; (ii) Hunton has continued to actively collaborate with GE's opposing counsel to the detriment of GE; (iii) Hunton has generated work product that Enzo is seeking to use contemporaneously against GE; and (iv) Hunton has confirmed Enzo's intent to use Hunton's future work product and any favorable rulings that Hunton obtains from this Court to Enzo's advantage in the New York Action.

(GE Mot. at 11-12.) Plaintiff argues in response that there is no direct adversity and that the "scenario is, at best for GE, a positional conflict" (Pls. Opp. Mem. at 17), and that "[t]he bottom line, however, is that attorneys represent clients — not

Case 1:05-cv-00439-GMS Document 10-8 Filed 06/12/2007 Page 15 of 21

legal positions or patents," Telectronics Proprietary, Ltd. v. Medtronic, Inc., 836 F.2d 1332, 1338 (Fed. Cir. 1988) (emphasis in original).

Hunton has represented GE Healthcare in inter alia intellectual property matters since November 2001 (Schulman Aff., Pls. Ex. 3, ¶ 3), and even though GE announced its acquisition of Amersham in October 2003 (GE Mot. at 3), Hunton nonetheless entered an appearance in October 2003 as Enzo's counsel in Applera (see Fedus Aff., Pls. Ex. 6, ¶ 3). Hunton claims that it "made clear to GE that it would have to communicate with the Greenberg firm in order to, e.g., deal with overlapping discovery issues and maintain the consistency of the claim construction positions advocated in the two cases." (Pls. Opp. Mem. at 24.) Horton claims that it was not until spring 2005 that he was informed that Hunton would be representing Enzo, and that although he was initially satisfied by representations of "a strict ethical wall," he "would never have consented to Hunton's assistance to Greenberg Traurig in the New York case or any collaboration between the Hunton and Greenberg Traurig firms." (Horton Aff., Pls. Reply Mem. Ex., ¶¶ 4, 9.)

GE argues that it was not provided with timely, full disclosure as to the extent of Hunton's engagement with Greenberg, such as Perez's appearance at the Ward deposition and the attempted sharing of the claim construction document. While

Perez's "appearance" at the Ward deposition was inappropriate, it was at the deposition of the patent holder's inventor, not of any Amersham or GE witness. Neither this nor the remainder of GE's record shows that the cooperation of Hunton and Greenberg has gone beyond that which is necessary "to assure that claim construction positions taken in Connecticut regarding the overlapping patents were consistent with positions taken in the New York Action," and nothing pertinent to Amersham's accused product or other alleged infringing conduct. (Perez Aff., Pls. Ex. 4, ¶ 5.)

In Fund of Funds v. Arthur Andersen & Co., 567 F.2d 225 (2d Cir. 1977), on which GE relies, plaintiff Fund of Funds had sued King Resources, Inc. and later brought a separate, related suit against Arthur Andersen, as King's accounting firm. The Second Circuit granted Arthur Andersen's motion to disqualify law firm Milgrim Thomajan, counsel for plaintiff Fund of Funds in the Arthur Andersen case, where Milgrim Thomajan had collaborated with law firm Morgan Lewis, which represented Fund of Funds in the King case and represented Arthur Andersen in other matters. Specifically, a Morgan Lewis attorney aided Milgrim Thomajan in drafting Fund of Funds's complaint against King, Morgan Lewis and Milgrim Thomajan shared an expert in the two cases, and lawyers from both firms interviewed a witness with respect to both actions at the offices of Milgrim Thomajan, although they

questioned the witness separately. See id. at 231-32. The Second Circuit held that "[i]n undertaking the background investigation, and in segregating the papers which were, in part, ultimately used against Andersen, Morgan Lewis was applying its privileged knowledge with respect to Andersen." Id. at 236.

In another case cited by GE, Freedom Wireless v. Boston Communications Group, Inc., No. 2006-1020 (Fed. Cir. Mar. 20. 2006) (unpublished), the Federal Circuit disqualified the firm Quinn Emanuel, counsel for the plaintiff, where plaintiff had obtained an injunction that would apply against Nextel, one of its other clients who was the defendant in a separate patent infringement case.

The disqualifications of counsel in Freedom Wireless and Fund of Funds do not counsel disqualification of Hunton in this case. While Perez's "appearance" at the Ward deposition and the submission of the claim construction chart raise initial superficial concern, "Hunton has never performed any substantive legal work for GE Healthcare with respect to . . . the patents . . . at issue in [Applera]" (Schulman Aff., Pls. Ex. 3, ¶ 5). Moreover, GE's concern about the preclusive effect of rulings on patent invalidity, see Allen Archery v. Browning Mfg. Co., 819 F.2d 1087, 1091 (Fed. Cir. 1987) (citing Miss. Chem. Corp. v. Swift Agricultural Chems. Corp., 717 F.2d 1374, 1376 (Fed. Cir. 1983)), is not in play in this case in the context of the

conflicting claim constructions in this case and Amersham, because there is no interlocutory appeal, and Hunton will not be involved in any future appeal affecting Amersham's interests. Simply put, while the construction of Enzo's patents applicable to the infringement claims brought against two separate accused infringers, Amersham and Applera, implicates pretrial Markman overlap, the trials of how those constructions apply to the respective accused products or conduct are wholly separate. GE has not claimed that any of its witnesses in Amersham will be cross-examined by Hunton in Applera, as contemplated as demonstrating direct adversity under Rule 1.7(a)(1).

It is true that because "[a] lawyer's duty to his client is that of a fiduciary or trustee," every client should have its lawyer's "undivided loyalty as its advocate and champion." Cinema 5, Ltd. v. Cinerama, Inc., 528 F.2d 1384 (2d Cir. 1976). However, GE takes too broad a view of this duty of loyalty in seeking disqualification of Hunton. The Court recognizes GE's concern that Hunton will be making arguments on behalf of Enzo with respect to patent validity that are contrary to the views of Amersham, but this issue is one relating to the circumstances of Enzo's patents and independent of the specific circumstances of Amersham. This situation has not been shown to constitute the prohibited representation of opposing parties in litigation, or implicating disclosures of attorney-client confidential

communications or knowledge. See, e.g., Freedom Wireless, No. 2006-1020 (Fed. Cir.). Disqualification is thus not warranted under Conn. R. Prof'l Conduct 1.7.

A balancing of Enzo's, GE's, and the public's interests under Hull v. Celanese Corp., 513 F.2d 568, 570 (2d Cir. 1975), confirms the appropriateness of denying the disqualification motion. The Court's denial of disqualification reflects some concern about prejudicing Enzo at this late stage in the litigation, even though the Court recognizes that Enzo is a sophisticated corporate conglomerate with in-house legal counsel and the ability to obtain replacement counsel, albeit at significant duplication of cost. General Electric's interest in preserving the duty of loyalty owed to it by Hunton is not compromised by the Court's decision: Hunton never represented GE in relation to its recently acquired entity Amersham and does not appear on behalf of its opponents in Amersham, and there is no evidence that Hunton has assisted Greenberg in representing Enzo beyond ensuring consistency in Markman issues. Finally, as this case has been before the Court since June 2004, disqualification would be imprudent in terms of the public's interest in efficient case management and utilization of judicial resources.

The balance tips toward denial of the disqualification motion, as GE has not met its heavy burden of showing the necessity of disqualifying Hunton from continued representation

of Enzo in a case in which GE is not a party, and where Hunton's clients are adverse to each other only insofar as they take opposite positions on a common legal issue in different cases pending in separate trial courts.

IV. Conclusion and Order

General Electric's Motion to Disqualify Plaintiff's Counsel [Doc. #121] is DENIED. In order to insure that Hunton's continued representation of Enzo in this case does not involve future activities which could result in a concurrent conflict of interest, the Court will enter the following Order which is to govern this case through conclusion, unless otherwise modified by the Court:

(1) Hunton will not assist Greenberg in any manner in the suit brought by plaintiffs in the New York action with respect to any legal, evidentiary, or other substantive issue in that case, including drafting briefs, motions, or other papers on behalf of plaintiffs for the purpose of submission in the New York action; commenting on, editing, revising, or suggesting briefs, motions, or other papers to Greenberg for purposes of the New York action; and providing legal or substantive advice to Greenberg for any purpose of the New York action;

(2) Hunton shall not prepare witnesses (including expert witnesses) for or attend depositions or hearings in the New York action;

(3) Hunton will not represent plaintiffs in any appellate proceedings that might result from this action or any appellate proceeding that would require Hunton to advance arguments inconsistent with any positions that have been, or may be, advanced by GE in the New York action; and

(4) Hunton shall provide Greenberg with a copy of this Order immediately.

IT IS SO ORDERED.

/s/

JANET BOND ARTERTON, U.S.D.J.

Dated at New Haven, Connecticut, this 5th day of January, 2007.

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP	§	
	§	
v.	§	Civil Action No. 2:05-cv-443 [TJW] JURY DEMANDED
	§	
COMCAST CORPORATION, COMCAST CABLE COMMUNICATIONS, LLC, and COMCAST OF PLANO, LP	§ § §	

**TIME WARNER CABLE INC.'S RESPONSE TO NOTICE OF
SUPPLEMENTAL AUTHORITY AND REQUEST FOR ORAL ARGUMENT**

TO THE HONORABLE JUDGE OF SAID COURT:

COMES NOW Time Warner Cable Inc. ("TWC") and presents to the Court its Response to Notice of Supplemental Authority and Request for Oral Argument as follows:

I.

On January 12, 2007, Plaintiff filed a Notice of Supplemental Authority (Dkt. 126), attaching a recent decision by the United States District Court, District of Connecticut. TWC will be pleased to address this decision along with any other issues raised by the parties' briefs and submissions and believes that the best way to do so is by oral argument. In this regard, TWC respectfully requests that the Court set an oral hearing on TWC's Motion to Disqualify (Dkt. 78) so that all issues in this matter may be properly presented for presentation to and ruling by this Honorable Court.

II.

WHEREFORE, PREMISES CONSIDERED, Time Warner Cable Inc. respectfully requests that the Court set an oral hearing on the Motion to Disqualify.

{A53\7477\0002\W0318266.2 }

Dated: January 17, 2007

Respectfully submitted,

/s/ Diane V. DeVasto
Michael E. Jones
Texas State Bar No. 10929400
mikejones@potterminton.com
Diane V. DeVasto
Texas State Bar No. 05784100
dianedevasto@potterminton.com
POTTER MINTON, P.C.
110 North College
500 Plaza Tower
Tyler, Texas 75702
Telephone: (903) 597-8311
Facsimile: (903) 593-0846

ATTORNEYS FOR
TIME WARNER CABLE INC.

Of Counsel:

David S. Benyacar
KAYE SCHOLER LLP
425 Park Avenue
New York, New York 10022
Telephone: (212) 836-8000
Facsimile: (212) 836-8689

CERTIFICATE OF SERVICE

The undersigned hereby certifies that all counsel of record who are deemed to have consented to electronic service are being served with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3) on January 17, 2007. Any other counsel of record will be served by first class on this same date.

/s/ Diane V. DeVasto

{A53\7477\0002\W0318266.2 }

Case 1:07-cv-00398-GMS Document 1-7 Filed 06/18/2007 Page 1 of 1

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP	§	
	§	
v.	§	Civil Action No. 2:05-cv-443 [TJW]
	§	JURY DEMANDED
COMCAST CORPORATION, COMCAST CABLE COMMUNICATIONS, LLC, and COMCAST OF PLANO, LP	§ § §	

ORDER SETTING HEARING ON MOTION TO DISQUALIFY

Before the Court is Time Warner Cable Inc.'s Response to Notice of Supplemental Authority and Request for Oral Argument.

After consideration of the response, the Court hereby sets the Motion to Disqualify (Dkt. 78) for hearing on ____

at __________ ______.m.

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP Plaintiff, v. COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP Defendants.	Civil Action No. 2:05-cv-00443-TJW

PLAINTIFF'S UNOPPOSED MOTION FOR LEAVE TO EXCEED PAGE LIMITS

TO THE HONORABLE JUDGE OF SAID COURT:

COMES NOW Plaintiff, Rembrandt Technologies, LP, and files this Unopposed Motion for Leave to Exceed the Page Limits, and would show the Court as follows:

Plaintiff respectfully moves the Court to permit Plaintiff to extend the page limits for its Reply Brief Regarding Claim Construction from 10 pages to 13 pages. Plaintiff's Reply Brief Regarding Claim Construction is attached hereto as Exhibit A.

WHEREFORE, PREMISES CONSIDERED, Plaintiff respectfully requests that the Court grant its Motion and permit Plaintiff to file its 13 page Brief, and for such other and further relief as Plaintiff may show itself justly entitled. This Motion is not brought for delay, but that justice might be done.

Case 2:07-cv-00398-GMS Document 1-1 Filed 01/17/2007 Page 2 of 3

Dated: January 17, 2007

Respectfully submitted,

FISH & RICHARDSON P.C.

By: /s/ Thomas A. Brown

Otis Carroll
State Bar No. 03895700
Wesley Hill
State Bar No. 24032294
IRELAND, CARROLL & KELLEY, P.C.
6101 S. Broadway, Suite 500
Tyler, Texas 75703
Tel: (903) 561-1600
Fax: (903) 581-1071
Email: fedserv@icklaw.com

Frank E. Scherkenbach
Lawrence K. Kolodney
Michael H. Bunis
Thomas A. Brown
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, MA 02110
Tel: 617-542-5070
Fax: 617-542-8906

Timothy Devlin
FISH & RICHARDSON P.C.
919 N. Market Street, Suite 1100
Wilmington, DE 19899-1114
Tel: 302-652-5070
Fax: 302-652-0607

Alan D. Albright
State Bar # 00973650
FISH & RICHARDSON P.C.
One Congress Plaza, 4th Floor
111 Congress Avenue
Austin, TX 78701
Tel: 512-391-4930
Fax; 512-591-6837

Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

Case 2:05-cv-00493-TJW Document 90-1 Filed 01/17/2007 Page 3 of 3

CERTIFICATE OF CONFERENCE

I hereby certify that on this 17th day of January, 2007, Plaintiff's counsel contacted counsel for Defendants regarding this Motion and Defendants do not oppose this Motion.

/s/ Thomas A. Brown
Thomas A. Brown

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 17th day of January, 2007, with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Thomas A. Brown
Thomas A. Brown

21536336.doc

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP **Plaintiff,** **v.** **COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP** **Defendants.**	**Civil Action No. 2:05-cv-00443-TJW**

PLAINTIFF REMBRANDT TECHNOLOGIES, LP'S REPLY BRIEF REGARDING CLAIM CONSTRUCTION

Frank E. Scherkenbach
Lawrence K. Kolodney
Michael H. Bunis
Thomas A. Brown
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, MA 02110
Tel: 617-542-5070
Fax: 617-542-8906

Timothy Devlin
FISH & RICHARDSON P.C.
919 N. Market Street, Suite 1100
Wilmington, DE 19899-1114
Tel: 302-652-5070
Fax: 302-652-0607

Alan D. Albright
State Bar No. 00973650
FISH & RICHARDSON P.C.
One Congress Plaza, 4th Floor
111 Congress Avenue
Austin, TX 78701
Tel: 512-391-4930
Fax: 512-591-6837

Otis Carroll
State Bar No. 03895700
Wesley Hill
State Bar No. 24032294
IRELAND, CARROLL & KELLEY, P.C.
6101 S. Broadway, Suite 500
Tyler, Texas 75703
Tel: (903) 561-1600
Fax: (903) 581-1071
Email: fedserv@icklaw.com

Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

TABLE OF CONTENTS

Page

TABLE OF AUTHORITIES

Page(s)

STATUTES

I. INTRODUCTION

Comcast's claim construction Response (Docket No. 121) includes a number of persistent errors, even from its opening words. For example, in its introduction, Comcast suggests that interpreting the claims more broadly than preferred embodiments – in other words, as they are written – is somehow improper, because the patents are being applied to later-developed cable technology in this case. (Response at 1.) The law is clear, however, that patents are frequently construed more broadly than the preferred embodiments. *Electro Med. Sys., S.A. v. Cooper Life Sciences, Inc.*, 34 F.3d 1048, 1054 (Fed. Cir. 1994) (holding that "particular embodiments appearing in a specification will not be read into the claims when the claim language is broader than such embodiments"). This is far different from construing the claims in a manner that is inconsistent with the specification, or, even worse, in a manner that excludes the preferred embodiments from the claims. Such constructions – including many proposed by Comcast – are plainly improper. *See Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1583 (Fed. Cir. 1996) (a construction that would exclude a preferred embodiment is "rarely, if ever, correct and would require highly persuasive evidentiary support").

Comcast makes other fundamental errors as well. While its Response includes a number of purported "incontrovertible rules" of claim construction (several of which Comcast proceeds to violate), the list conveniently omits several well-known principles:

- Claims should not be limited to the preferred embodiment. *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1328 (Fed. Cir. 2002) (cautioning against limiting the claimed invention to a preferred embodiment in the specification).

- Different language in claims generally leads to different meanings. *CAE Screenplates, Inc. v. Heinrich Fielder GmbH & Co. KG*, 224 F.3d 1308, 1317 (Fed. Cir. 2000) ("In the absence of any evidence to the contrary, we must presume that the use of these different terms in the claims connotes different meanings.")

- Extrinsic evidence should be rejected where it is inconsistent with the patent claims or specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1318 (Fed. Cir. 2005) (*en banc*) (stating that a court should discount extrinsic evidence that is at odds with the intrinsic evidence).

- Expert testimony on the meaning of claim terms should be viewed with scrutiny. *Phillips*, 415 F.3d at 1318-1319 (noting the unreliability of expert testimony as compared to intrinsic evidence).

Comcast's Response violates these rules over and over again and further shows why Rembrandt's constructions are the right ones.[1]

II. DISCUSSION

A. U.S. Patent No. 5,719,858

1. time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)

Comcast makes three separate arguments regarding the TDM bus limitation, none of which has any merit. Comcast first argues that Rembrandt does not further define the term "bus," but Comcast itself states that "***it is understood*** that a bus is a group of (one or more) conductors shared by several users (*i.e.*, transmitting and receiving sources)." (Response at 3.)[2] There is simply no need to define this easily understood term using more words, particularly when one of those words – conductor – may be confusing and incorrect. Comcast may attempt to argue, for example, that the term "conductor" does not include a fiber optic connection, but fiber optics were well known in 1995 to communicate data.

Second, Comcast asserts that a TDM bus "requires that the transmission sequence be defined . . . ." (Response at 3.) This statement, like Comcast's construction, directly contradicts the '858 patent specification. In the preferred embodiment there is ***no defined transmission sequence*** for the data sources which use the TDM bus. This is shown best in Figure 6 of the '858 patent, in which Module 6 follows Module 2, skipping over Modules 3, 4 and 5. Later on this order could change, depending on when each Module has data to send. (Ex. 25 at 62:21-64:11; *see also* 58:16-59:6.)[3]

---

[1] It should be noted that, due to space constraints, Rembrandt does not delineate every error in Comcast's brief, nor does Rembrandt even address all claim limitations. No such omission is intended to suggest agreement with Comcast's position; Rembrandt rests on its opening brief and will be prepared to address such issues, if the Court wishes, at the upcoming hearing.

[2] Unless otherwise indicated, emphasis in this Reply has been added.

[3] Exhibits 1-24 refer to exhibits attached to Rembrandt's Opening Claim Construction Brief (Docket No. 119). Exhibits 25-28 are attached to this Reply Brief. Exhibits 7 and 8 to Rembrandt's Opening Claim Construction Brief include rough transcripts of the depositions of Drs. Curtis Siller and Harry Bims. Exhibits 25 and 26 to this Reply include the final

Third, Comcast tries to avoid this problem by arguing that in the ’858 patent, over repeated frames, consistent portions of bandwidth are allocated collectively to the packet sources and synchronous sources. (Response at 4.) In other words, according to Comcast, because there is some repetition to how different groups of sources access the bus, the ’858 patent specification is consistent with Comcast’s construction. Even if Comcast’s characterization of the ’858 patent were true, the argument fails to cure the problems in Comcast’s construction. That construction requires that “each user,” not a group of users, access the bus in a defined, repeated sequence. In light of this proposed language, it is inexplicable how Comcast asserts that its construction “does not even relate to what data source is allowed to transmit at a particular time.” (*Id.* at 4.) This statement is belied by its own proposed construction.

Comcast’s construction would read out the preferred embodiment of the ’858 patent, and should be rejected.

2. packet data (claims 1, 7, 9, 11, 15 and 20); synchronous data (claims 7, 9, 11)

Comcast attempts to draw the line between packet and synchronous data according to the format of the data, *i.e.* whether it includes header information or not. This forces Comcast to (1) ignore an express definition within the ’858 patent, and (2) ignore its own expert’s Declaration.

As set forth in Rembrandt’s opening brief and conceded by Comcast, the ’858 patent expressly defines packet data as “variable-bit-rate” data. (Ex. 1 at 1:9-10; Response at 5.) This is the construction proposed by Rembrandt, and there is nothing in the specification to the contrary. Comcast wrongly suggests that Rembrandt seeks to “limit” the term beyond this definition. (Response at 5.) Rembrandt simply proposes that the proper construction is the express definition set out in the specification.

Comcast’s arguments regarding “synchronous data” are belied by its own expert. Dr. Siller states in his Declaration that “synchronous” refers to “a mode of transmission in which the sending and receiving equipment are operating continuously at the same rate and are maintained

versions of each of these transcripts, including pages cited in Rembrandt's Opening Claim Construction Brief.

in a desired phase relationship." (Siller Decl. at ¶ 23.) This description makes no reference to the format of the data. Indeed, Comcast admits that synchronous data "can be sent in packets." (Response at 5.) There is no basis in the patent or otherwise to limit synchronous data to data "not transmitted in packets," as Comcast proposes.

Comcast's reference to the prosecution history wrongly cites the Examiner's description of a prior art reference, not the '858 patent invention. (Comcast Ex. 4 at 2-3.) Moreover, the Examiner's statements are not a basis for contradicting an express definition within the specification. *Sorensen v. Int'l Trade Comm'n*, 427 F.3d 1375, 1379 (Fed. Cir. 2005) (noting that "the statements of an examiner will not necessarily limit a claim").

**3. distributed packet manager (claims 1, 7);
allocate access to the allotted bandwidth among said packet data sources [and corresponding limitations] (claims 1, 7, 15, 20)**

Comcast would improperly require the "distributed packet manager" to perform every function for placing packet data on the bus. This once again reads out a preferred embodiment, because the '858 patent itself describes that the central "network access module" or "NAM" is what reserves a portion of bus bandwidth for the packet sources. (Ex. 1 at 5:11-13.) The '858 patent does not demand the complete elimination of all central control, as Comcast proposes. (Comcast's construction of "network access module" is also incorrect for this same reason.)

Comcast also seeks to read into these limitations a requirement of preventing packet collisions, but even Comcast's brief shows that such a construction would limit the patent to the preferred embodiment, namely "a specific solution . . . whereby only one packet source 'captures' permission to use the MAPC at a time." (Response at 8.) This "specific solution" is the preferred method of access, using "packet request" and "packet hold" signals, described at columns 7 to 10. Comcast cites no support that justifies limiting the patent to this embodiment. This is particularly true in light of known methods of time division multiplexing that allow for packet collisions. (Ex. 25 at 92:22-93:14.)

Comcast's attempts to avoid the doctrine of claim differentiation have no merit. Its cases are inapplicable, because they relate to situations where claim differentiation would lead to a

construction that was incompatible with the specification and would render a claim term "nearly meaningless." *See Curtiss-Wright Flow Control Crop. v. Velan, Inc.*, 438 F.3d 1374, 1379 (Fed. Cir. 2006); *Hormone Research Found. v. Genentech, Inc.*, 904 F.2d 1558, 1567 n.15 (Fed. Cir. 1990). That is not the case here. Moreover, the '858 patent includes dependent claims that recite the "specific solution" for allocating access which Comcast seeks to import into the independent claims. (*See, e.g.,* claim 2, reciting the "packet request" and "packet hold" signals.) Comcast's efforts to effectively read these dependent limitations into broader independent claims should be rejected, as set forth in Comcast's own cited case law. *Curtiss-Wright*, 438 F.3d at 1380 (observing that "reading an additional limitation from a dependent claim into an independent claim would not only make that additional limitation superfluous, it might render the dependent claim invalid").

B. U.S. Patent No. 4,937,819

1. application program[s] (claims 1, 14)

Having failed initially to cite any relevant evidence in support of its construction for "application program," Comcast now cites to two new extrinsic sources. One of the sources (the IEEE dictionary) is five years late, and the other source (Newton's Telecom) actually supports Rembrandt's construction: "APPLICATION[:] A software program that carries out some useful task." (Comcast Ex. 13.)

Comcast's arguments also mischaracterize the intrinsic record. Contrary to Comcast's assertion, the prosecution history ***broadened*** the phrase "host application" to "application program," so that the program in question no longer needed to be running at a central host. This is clear from the following Office Action, after the claim was broadened, in which the Examiner refers to using a "remote unit to execute [an] application program." (Ex. 27 at 4.) Also contrary to Comcast's suggestion, there is no inconsistency between Rembrandt's construction and the patent specification, because there is no requirement that every single program have an associated channel. The patent claims include the phrase "comprising," and so can accommodate additional elements such as extra programs that do not require any data

transmission. *CollegeNet, Inc. v. ApplyYourself, Inc.*, 418 F.3d 1225, 1235 (Fed. Cir. 2005) ("The transitional term 'comprising' . . . is inclusive or open-ended and does not exclude additional, unrecited elements or method steps.").

Finally, Comcast's selective citation of inventor testimony ignores the general statement by the inventor that his invention is "transparent to the application." (Ex. 23 at 58:6-7.)

2. time slot assigned to each of said application programs (claim 1); dividing a period of a clock . . . (claim 14)

The primary dispute regarding these elements is whether time slots can be assigned dynamically. Comcast's efforts to read out this capability are contrary to the plain teachings of the patent. Although one disclosed method of assigning time slots is to do so at initialization, the patent discloses another method by which remote units request additional time slots during transmission, and the time slots are assigned at that time.

Comcast concedes all of the patent disclosure regarding this second method (Response at 12), but somehow seeks to avoid calling this procedure an "assignment" of time slots. This strained interpretation makes no sense. In fact, ***the '819 patent itself refers to this dynamic allocation as an "assignment" of time slots***. Figure 8 shows a flow chart of the preferred dynamic allocation method, in which a remote unit makes a "reservation request" for additional time slots, and they are granted by the master unit. (Ex. 2 at Fig. 8.) The notation on the right hand side of Figure 8 refers to the grant as "***Assignment*** of Transmission Period for Reservation Requests." Comcast's efforts to construe the claim so as to exclude this disclosure should be rejected.

Comcast also wishes to read in further limitations regarding whether information is "packetized," but this overstates the arguments made during prosecution. A disclaimer in prosecution must be "clear and unmistakable." *SanDisk Corp. v. Memorex Prods., Inc.*, 415 F.3d 1278, 1286 (Fed. Cir. 2005). Where as here the patentee merely differentiated prior art on a number of exemplary bases, the argument does not rise to the level of a disclaimer. *Gemstar-TV Guide Int'l, Inc. v. Int'l Trade Comm'n*, 383 F.3d 1352, 1375 (Fed. Cir. 2004) ("Gemstar's

statements in the prosecution history do not indicate a disavowal or disclaimer of claim scope . . . but merely provide an example to illustrate differences between the invention and the prior art.").

3. master network timing means . . . (claim 1)

Comcast mistakenly asserts that the "master network timing means" limitation recites a function, but in fact it merely recites a "wherein" clause that defines some features of how bandwidth is partitioned in the '819 patent. Even if the "wherein" clause is interpreted as functional language, the patent specification does not associate it with the master network timing means. Comcast itself concedes that a user can set up these partitions, not the master network timing means. (Response at 15.) Accordingly, this limitation does not meet the requirements for the application of 35 U.S.C. § 112, ¶ 6.

Comcast belatedly raises an indefiniteness argument premised on the fact that its purported "function" is not associated with a purported "algorithm." (Response at 14, n. 11.) Citing Rembrandt's expert Dr. V. Thomas Rhyne, Comcast falsely asserts that the "parties agree that the network timing and control processor 12 performs the claimed functions." (*Id.* at 14.) Rembrandt does not agree, and Dr. Rhyne's declaration says no such thing. Moreover, Comcast's indefiniteness argument was never raised in its Invalidity Contentions or previously in claim construction disclosures, and should be rejected. If anything, Comcast's admission that its purported "function" is not associated with a purported "algorithm" only confirms that § 112, ¶ 6 should not apply.

As set forth in Rembrandt's opening Brief, the patent specification discloses a clock that keeps network timing, and this is the only construction needed to capture the meaning of a "master network timing means."

4. ranging means . . . (claim 1)

In its Response, Comcast virtually ignores the essential problem with its proposed construction. Specifically, the function Comcast seeks to associate with the "ranging means" is in fact associated with the master unit, not the ranging means. This function can be performed by other components of the master unit. Comcast's only response is a conclusory footnote, in

which it notes that the ranging means is within the master unit. (Response at 15.) This statement does nothing to correlate any function with the "ranging means" itself, as would be required for the application of § 112, ¶ 6. Comcast's expert conceded this very point in deposition. (Ex. 25 at 181:23-182:14.)

5. reservation request generator and processor (claim 2); priority bit (claim 11)

These limitations are further examples of Comcast seeking to restrict the claims to a single preferred embodiment described in the specification. Such restrictions are improper, and should be rejected. *Teleflex*, 299 F.3d at 1328 (cautioning against limiting the claimed invention to a preferred embodiment in the specification).

C. U.S. Patent No. 5,852,631

Only two substantial disputes among the parties remain with respect to the '631 patent: "link layer" and two means-plus-function terms.[4]

1. link layer (claims 1, 3, 4, 6, 8, 9, and 10)

a. Rembrandt's Construction Is the Most Faithful to the Intrinsic Evidence

The '631 patent refers to "error correction" forty-eight times in the context of a link layer protocol. (Ex. 3 at 1:53; 2:42, 46, 47, & 49; 4:28; 6:59, 62, 64 & 65; 7:29, 39, 49 & 63; 11: 26, 32, 35, 43, 60, 64 & 67; 12: 1, 3, 5, 10, 11, 24, 28, 30, 43, 51, 55 & 58; 13: 2, 4, 21, 22, 25, 27, 31, 37, 38 & 39; 14: 3, 43, 48 & 67). In not one of these instances does the '631 patent limit the ***kind*** of error correction that is to be accomplished by the link layer. Comcast nonetheless seeks to restrict the scope of the '631 patent to link layer protocols utilizing frame retransmission, on the basis of an out-of-context snippet from a single sentence in the '631 patent.

When read in full, however, this sentence provides no support for Comcast's position:

---

4 With respect to the term "negotiated physical layer modulation," Rembrandt does not dispute that a negotiation requires an exchange of information, nor that the negotiation must take place at run time. These concepts are already inherent in Rembrandt's proposed construction (requiring that the modems "***agree*** on a common supported physical layer modulation").

> The data link layer is the second lowest layer ***of the OSI seven layer model*** and is provided to perform error checking functions as well as retransmitting frames that are not received correctly.

(Ex. 3 at 1:11-14.) This sentence does not purport to define the link layer, but merely incorporates – and partially characterizes – a pre-existing concept of "link layer" defined in the OSI seven layer model. The seminal Zimmerman article introducing this model broadly defines the link layer as encompassing those "specific techniques to be used in order to transmit data between systems despite a relatively high error rate . . . ." (Ex. 16 at 429.) Nothing in the Zimmerman article limits link layer error correction to a particular type, such as frame retransmission. To the contrary, Zimmerman explicitly recognizes that the types of error control procedures that may be found in the link layer may change over time. "It must also be recognized that new physical communications media . . . will require quite different data-link control procedures [from those already in standard use]." (*Id.* at 429.)

The patent claims themselves support this understanding. Claim 1 recites a "method for establishing a link layer connection." (Ex. 3 at 14:25.) Claim 3 depends from claim 1 and further requires that "said link layer connection is an error-correcting protocol." (Ex. 3 at 14:42-43.) Yet Comcast would have this Court rule that claim 1 is already limited to error-correcting protocols ***that operate through frame retransmission*** – in other words, that independent claim 1 is narrower than dependent claim 3. Such a construction is impermissible. *See* 35 U.S.C. § 112, ¶ 4 ("a claim in dependent form shall . . . specify a further limitation of the subject matter claimed"); *Lampi Corp. v. Am. Power Prods., Inc.*, 228 F.3d 1365, 1376 (Fed. Cir. 2000) (construing an independent claim to ensure that a dependent claim was not of broader scope).

In short, no one disputes that, where used, frame retransmission is part of the link layer. But nothing in Zimmerman or the '631 patent suggests that frame retransmission is a ***necessary*** feature of the patent.

b. Error Correction Is a Link Layer Feature

Comcast maintains that because the V.34 standard includes a protocol for establishing a physical layer connection, and also includes trellis encoding, that trellis encoding must be part of

the physical layer. (Response at 22.) This argument is may easily be dismissed because ***Comcast's own expert*** testified that protocols like the V.34 standard include functionality in multiple layers: "There are many examples of communications protocol standards that encompass multiple layers in the OSI protocol model." (Ex. 26 at 93:17-19.) Comcast's expert also explained that "it's generally understood as to which functions go within which layer of the OSI protocol model." (*Id*. at 94:7-9.)

In view of the repeated statements in the '631 patent and the Zimmerman article that error correction is a function of the link layer, this testimony confirms that the V.34 protocol spans multiple layers of the OSI model. While some of the V.34 protocol's functionality relates to the physical layer, the trellis-encoding functionality, which pertains to error correction, exists within the link layer.

c. The Extrinsic Evidence Supports Rembrandt's Construction

Comcast's citations to treatises and dictionary definitions to buttress its link layer argument are unavailing. While as noted above frame retransmission was one known method of implementing link layer error correction, this was clearly not the only known method. Comcast acknowledges that the Lim article (Ex. 20), published only shortly after the filing date of the '631 patent, utilizes a form of error correction in the link layer that does not use frame retransmission. (Response at 23; Bims Decl. ¶ 22.) Even a patent issued to Comcast's own expert clearly states that error correction in the link layer can be achieved through Reed-Solomon coding, as opposed to frame retransmission. (*See* Ex. 28 at 8:6-9 ("In one embodiment, data link layer 408 is implemented . . . with Reed-Solomon decoding . . . ."))

2. Comcast's Indefiniteness Argument Violates the Local Rules and Is Contradicted by Its Own Expert

In Comcast's opening claim construction brief, Comcast argues for the first time that two means-plus-function terms in the '631 patent[5] are invalid as indefinite. Comcast's argument

[5] "means for establishing said link layer connection based upon the negotiated physical layer connection" and "means for presetting said link layer parameters based on the negotiated physical layer modulation."

comes too late. P.R. 3-3(d) requires that Comcast disclose any indefiniteness argument in its Preliminary Invalidity Contentions, but no such disclosure was made. Nor did Comcast contend that these terms were indefinite when the parties filed their Amended Joint Claim Construction Statement. (*See* Docket No. 112 at A-15 – A-17.) Nor did Comcast's expert opine that these terms were indefinite. (Ex. 26 at 241:15-242:3; 242:18-24; *see also id.* at 214:7-13.) Because Comcast can cite no evidence supporting its indefiniteness argument, and because Comcast provided no notice to Rembrandt of its position, the Court should not entertain Comcast's late contentions now and should adopt Rembrandt's proposed construction.

D. U.S. Patent No. 5,243,627

Comcast's constructions of the '627 patent exemplify one of the basic methodological defects described at the outset of this brief. When conducting claim construction, the court should "rely heavily on the written description for guidance as to the meaning of the claim terms." *Phillips*, 415 F.3d at 1317. Comcast instead relies extensively on extrinsic evidence and unsubstantiated claims of its expert, while treating the patent specification – the "single best guide" for claim construction, *id.* at 1315 – as an afterthought. Because Comcast's constructions depart from (and at least in one case contradict) the explicit teaching of the '627 patent specification, they are incorrect as a matter of law.

1. trellis encoded channel symbol (claims 9, 19)

Comcast's construction of this term requires trellis encoded channel symbols to be generated using the outputs of a "single state transition" of the trellis encoder. Comcast asserts that its construction is consistent with the preferred embodiment because the patent is purportedly "clear" that pairs of subset identifiers are "generated in parallel" and thus generated during a single state transition. (Response at 29.) The reality is that Comcast points to nothing in the specification that supports this notion. It relies instead exclusively on its expert. (Response at 29; Bims Decl. ¶ 53.)

The patent specification, in fact, teaches exactly the opposite of what Comcast contends. It repeatedly states that subset identifiers are generated sequentially rather than in parallel.

- "[T]he words identified on lead 109 are used by trellis encoder 119α to ***sequentially*** identify on lead 121 N subsets . . . ." (Ex. 4 at 3:53-55.)
- "A ***succession*** of N outputs from the trellis encoder identifies a particular one of the 2N-dimensional subsets . . . ." (*Id.* at 4:19-21.)

Since Comcast's proposed construction would exclude the channel symbols specifically described in the '627 patent, that construction is presumptively incorrect. *Primos, Inc. v. Hunters Specialties, Inc.*, 451 F.3d 841, 848 (Fed. Cir. 2006) (noting that "we also should not normally interpret a claim term to exclude a preferred embodiment").

2. signal point (claims 9, 19)

Comcast claims that the term "signal point" is "overwhelmingly" used to refer to a "mapped" point in a signal constellation. (Response at 31.) Yet Comcast does not identify a single description of this "mapping," either in the '627 patent or in its own extrinsic evidence. Comcast's citations to the '627 patent ("[t]his constellation is comprises of 32 signal points, which are divided into four subsets, A through D, each comprised of eight signal points") and to the extrinsic evidence '000 patent ("[e]ach signal point in the [signal] constellation has an associated bit code") mention nothing about mapping. (Response at 30-31.) Comcast's inclusion of "mapped" in its construction is unsubstantiated, making its construction incorrect.

Comcast's sole argument against Rembrandt's construction is that signal points are not transmitted. The patent specification, however, directly contradicts this argument. "Those two signal points are thereupon ***communicated over the channel*** by QAM encoder 124 and modulator 128 as described above." (Ex. 4 at 4:1-3.) Moreover, Comcast's expert also concedes that signal points are transmitted. (Bims Decl. ¶ 35 ("Each signal point corresponds to certain waveform characteristics (e.g., amplitude, frequency, etc.), and as such can be ***transmitted over the medium*** (e.g., a wire)."))

3. distributed Viterbi decoder (claims 9, 19)

By requiring "two or more Viterbi decoders" in its construction, Comcast completely fails to address the explicit disclosure of the '627 patent cited in Rembrandt's opening brief.

> [M]ultiple trellis encoders and decoders can be realized using ***a single program routine which***, through the mechanism of indirect addressing of multiple arrays within memory, ***serves to provide the function of each of the multiple devices***.

(Ex. 4 at 9:61-66.) The specification makes clear that the distributed Viterbi decoder can be implemented as a single Viterbi decoder that emulates the function of multiple physical devices. Such a distributed Viterbi decoder, contrary to Comcast's assertion, is distinguishable over a prior art Viterbi decoder because it has multiple, rather than a single, Viterbi decoding processes.

4. means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols (claim 9)

Comcast asserts that the function of this limitation is "expressly limited to reversing the signal point interleaving" that is performed by interleaver 341 in the transmitter. (Response at 33.) This notion is contradicted by the claim language itself, which states that the claimed deinterleaving must "recover [a] plurality of streams of trellis encoded channel symbols" – a function that is clearly performed by switching circuit 431. (*See* Ex. 4 at Fig. 4.)

Comcast is also incorrect that switching circuit 431 "by itself" cannot deinterleave the interleaved signal points. (Response at 33-34.) The claims describe interleaving signal points ***in two different ways***: one way ensures that "signal points of each channel symbol are non-adjacent" and a second way causes "signal points of adjacent symbols in any one of said channel symbol streams [to be] non-adjacent." The corresponding structure identified by Comcast – essentially the deinterleaver 441 – is involved in reversing only the first of those processes, and is therefore incomplete. By contrast, Rembrandt's construction correctly identifies ***both*** of the structures that perform deinterleaving in the '627 patent.

Dated: January 17, 2007

Respectfully submitted,

FISH & RICHARDSON P.C.

By: /s/ Thomas A. Brown

Otis Carroll
State Bar No. 03895700
Wesley Hill
State Bar No. 24032294
IRELAND, CARROLL & KELLEY, P.C.
6101 S. Broadway, Suite 500
Tyler, TX 75703
Tel: (903) 561-1600
Fax: (903) 581-1071
Email: fedserv@icklaw.com

Frank E. Scherkenbach
Lawrence K. Kolodney
Michael H. Bunis
Thomas A. Brown
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, MA 02110
Tel: 617-542-5070
Fax: 617-542-8906

Timothy Devlin
FISH & RICHARDSON P.C.
919 N. Market Street, Suite 1100
Wilmington, DE 19899-1114
Tel: 302-652-5070
Fax: 302-652-0607

Alan D. Albright
State Bar No. 00973650
FISH & RICHARDSON P.C.
One Congress Plaza, 4th Floor
111 Congress Avenue
Austin, TX 78701
Tel: 512-391-4930
Fax; 512-591-6837

Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the above and foregoing document has been served on seventeenth day of January, 2007 to all counsel of record who are deemed to have consented to electronic service via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by first class mail.

Brian L. Ferrall, Esq.
Leo L. Lam, Esq.
Eric MacMichael, Esq.
Keker & Van Nest, L.L.P.
710 Sansome Street
San Francisco, CA 94111-1704

Attorneys for Defendants
Comcast Corporation, Comcast Cable Communications, LLC and Comcast of Plano, LP

Jennifer Haltom Doan, Esq.
John Peyton Perkins, III, Esq.
Haltom & Doan, LLP
6500 N. Summerhill Road
Crown Executive Center, Suite 1A
P. O. Box 6227
Texarkana, TX 75505-6227

Attorneys for Defendants
Comcast Corporation, Comcast Cable Communications, LLC and Comcast of Plano, LP

/s/ Thomas A. Brown
Thomas A. Brown

21534251.doc

Case 1:07-cv-00493-GMS Document 19-3 Filed 06/21/2007 Page 1 of 23

Exhibit 25

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP)
)
Plaintiff,)
)
vs.) No. 2:05-cv-00443-TJW
)
COMCAST CORPORATION; COMCAST)
CABLE COMMUNICATIONS, LLC;)
AND COMCAST OF PLANO, LP)
)
Defendants.)
______________________________)

VIDEOTAPED DEPOSITION OF CURTIS A. SILLER, Ph.D.,
San Francisco, California
Wednesday, December 20, 2006

Reported by:
Rebecca Romano,
CSR No. 12546
Job No. 201462

San Francisco, California, Wednesday, December 20, 2006
9:27 A.M. - 4:22 P.M.

(Siller's Exhibit Nos. 1 through 4 were marked for identification.)

THE VIDEOGRAPHER: Good morning. Here begins Videotape No. 1 in the deposition of Curtis Siller in the matter of Rembrandt v. Comcast in the United States District Court for the Eastern District of Texas Marshall Division, Case No. 205-CV-00443-DJW.

Today's date is December 20th, 2006. The time is 9:27 A.M.

This deposition is being taken at 710 Sansome Street, San Francisco, California. The videographer is Marty Marjoub, here on behalf of Esquire Deposition Services, 505 Sansome, Suite 502, San Francisco, California.

Will all counsel present please identify yourselves and state whom you represent.

MR. DEVLIN: Tim Devlin of Fish & Richardson for plaintiff Rembrandt.

MR. WERDEGAR: Matthew Werdegar of Keker & Van Nest for defendant Comcast. Also present is Audrey --

MS. WALTON-HADLOCK: Walton-Hadlock.

MR. WERDEGAR: -- Walton-Hadlock.

Case 2:05-cv-00493-TJW Document 190-13 Filed 06/18/2007 Page 4 of 23

over. I think I --
The part on the left is the packet channel.
A Understood you to have said that, yes.
Q Let me just say it all again clearly.
A Okay.
Q We'll start from the start.
We're looking at that dotted line down the middle of figure 5. And it divides it into two regions, right?
A Correct.
Q The region on the left is the channel for packet sources.
MR. WERDEGAR: Objection. Form.
Q (By Mr. Devlin) Is that fair?
A Yes.
Q And the region on the right are the channels for the synchronous sources.
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Not labeled as such, but I would infer that to be the case.
Q (By Mr. Devlin) There are time slots shown on the left-hand side of the figure.
A Right.
Q What are those?
MR. WERDEGAR: Objection. Form.

THE DEPONENT: Those are individual time slots, fixed in size, that make up a portion of the part of the overall frame that is set aside for packet communications.

Q (By Mr. Devlin) On the right-hand side of the figure it doesn't actually say the word "time slot."

Do you see that?

A Yes, I see that.

Q Based on your understanding and reading of the entire patent, is it your understanding that those time slots exist on the right-hand side of the figure also?

A That would be my understanding.

Q They are just not shown in figure 5.

MR. WERDEGAR: Objection. Form.

Q (By Mr. Devlin) Is that fair?

A That's fair.

Q There's a designation that says, "Start of packet 50."

Do you see that?

A I do.

Q And that starts -- a thick bold line that starts on frame 1, ends at that dotted line, and then continues onto the left-hand side of frames 2 and 3, continues into frame 4, again, on the left-hand side, and then ends.

Q Are you able to tell from figure 5 which of the packet data sources would transmit the next packet after the one that's shown?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Not from figure 5.
Q (By Mr. Devlin) If you knew from the text of the patent -- this is a hypothetical.
If the text of the patent told you which of the packet data sources was transmitting that packet --
A Uh-huh.
Q -- in figure 5 --
A Yes.
Q -- could you then tell me what the next packet source would be to transmit a packet?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: I could not.
Q (By Mr. Devlin) Why is that?
A Because the very next -- next one may not have any information to send.
Q And if it doesn't, what would happen?
A It would go to the next one.
Q So there's no particular order in which the packet data sources have to transmit data in the '858 patent invention.
MR. WERDEGAR: Objection. Form.

THE DEPONENT: I believe this is description of a sequential process in which there is a sequential arbitration to invite the individual packet modules to transmit.

Q (By Mr. Devlin) Let me -- let me see if I can get an answer. This is a foundational question.

There's --

A What is --

Q -- no actual --

A What is a foundational question?

Q I just want to get a more basic bit of information --

A Oh.

Q -- from you.

A Okay.

Q In the '858 patent, there's no actual sequence by which the packet sources have to transmit their information.

MR. WERDEGAR: Objection.

Q (By Mr. Devlin) Is that fair?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: I think that's fair.

Q (By Mr. Devlin) And what you were saying before is that there is some sequence of arbitration, right?

A Yes.
Q But that arbitration doesn't mean that the packet data's -- data sources will actually transmit in a given sequence.
MR. WERDEGAR: Objection. Form.
THE DEPONENT: That's right.
Q (By Mr. Devlin) In fact, let's turn to figure 6.
Could you describe for me what's happening in figure 6 of the '858 patent?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Yeah. I will try to describe it.
Time is shown as elapsing across the top.
Q (By Mr. Devlin) From left to right?
A Yes, from left to right.
Q Thank you.
A And there is a suggestion that among the packet data there have been -- has been a closing flag indicating that one of the packet sources has ceased communicating.
Q Can I ask you where you are referring to that closing flag?
A It's in the lower left-hand part of figure 6.

further on the right for P6, between what's designated as T19 and T23, I suppose it would be. Between T19 in the right-hand side of the figure, the only packet data source that's transmitting is P6.
Fair to say?
A Again, that would --
MR. WERDEGAR: Objection. Form.
THE DEPONENT: That would be my interpretation.
Q (By Mr. Devlin) Okay. So just to summarize this figure, figure 6, we are moving from the left to the right, and first, packet source 2 transmits information, then there's a closing flag, and then the next packet source to transmit information is packet 6.
MR. WERDEGAR: Objection. Form.
Q (By Mr. Devlin) Is that -- is that a fair interpretation of the figure?
A Yes. If we overlook the fact that the preceding module, which is not identified, has transmitted its closing flag.
Q Will -- will module 6 always transmit information after module 2?
MR. WERDEGAR: Objection. Form.
Q (By Mr. Devlin) Based on your understanding of the '858 patent?

A I don't think that's a necessary condition.
Q Why is that?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Because module 2 and the preceding modules may have had nothing to transmit at all.
Q (By Mr. Devlin) So -- so I'm saying, next time around, module 2 may transmit again sometime later in time, correct?
A It may or may not.
Q It may never transmit information again.
Is that fair?
A That's true.
Q If it did, would it necessarily follow that module 6 would be the next module to transmit information?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: This level of detail is getting outside my area of expertise in terms of how the actual arbitration process works for the packet modules on the bus.
Q (By Mr. Devlin) Is it your understanding that the next time module 2 transmitted information, it could be followed by module 3?
MR. WERDEGAR: Objection. Form.

Q (By Mr. Devlin) Is that fair?
A Yeah.
Q Or module 4?
A Possibly.
Q Just depends on who has information to send after module 2 and the nature of the arbitration technique that's used.
MR. WERDEGAR: Objection.
Q (By Mr. Devlin) Is that fair?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: That's right.
Q (By Mr. Devlin) In figure 6, there's something called a P-R-E-Q, all capital letters next to one another.
Do you see that?
A Yes.
Q And then there is something called a P-H-O-L-D.
A Okay.
Q I sometimes refer to that as PREQ and PHOLD.
Is that how you refer to those?
A I don't really refer to them because, as I indicated, the details of the arbitration technique for the packet sources to get on is outside my area of expertise.

Q Do you see a paragraph beginning around line 18?

A Yes, I do.

Q Reference to something called asynchronous transfer mode, ATM?

A That's right.

Q Do you have an understanding of what ATM is?

A Yes, I do.

Q What is it?

A It's a packetization technique for carrying a variety of traffic, and it's most noted by the fact that the packets are fixed in size.

Q Why are they fixed in size?

A It was a compromise between the telecommunication and the data industry that the particular size of the packets that are used for ATM, if carrying voice, are well-suited to the PSTN, the public switch telephone network.

Whereas, people working in the computer industry are more inclined to want to send information in a packetized form, so they compromised on the size that met the needs of telephony and a fact that packetization is used for data communications.

Q What do you mean by "telephony"?

A Telephone calls.

Q There is a sentence that begins at around line 22, "In the case of ATM."
Do you see that?
A Yes. "In the case of ATM."
Q Yeah. I will just read that sentence.
And it says, "In the case of ATM cells, the oxidants which form the cells need to be aligned within DS0 channels."
Do you see that?
A I do.
Q Do you have an understanding of what an ATM cell?
A Yes, I do.
Q That's that 48 bits you were just talking about?
A Well, it's actually 53. And they are bytes.
Q Oh, 53 bytes. Thank you.
Is there anything else that makes up part of an ATM cell?
A Well, it has the two ingredients. It has the header. It has the information field. Part of the AT -- information field can be given over to what they call the ATM adaptation layer.
Q What is in the header?
A The header would contain addressing

information. Yeah, addressing information.

Q Anything else?

A It may indicate the fact -- what type of AAL, ATM adaptation layer is being used. There are five, AAL 1 through AAL 5.

Q Okay. Are ATM cell -- when you are using an asynchronous transfer mode network --

A Uh-huh.

Q -- are ATM cells used for both the packetized data and for telephony?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Would you repeat the question one more time.

Q (By Mr. Devlin) Yeah. Let me try to ask a simpler one.

Are ATM cells used for telephony applications in ATM networks?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Yes, they are.

Q (By Mr. Devlin) That sentence continues to say, "The octecs which form the cells need to be aligned within DS0 channels."

Do you see that?

A I do.

Q Do you understand what I mean by octecs?

Case 2:07-cv-00493-TJW-CE Document 190-3 Filed 06/28/2007 Page 16 of 23

MR. WERDEGAR: Objection. Form.
THE DEPONENT: It says on the second line that it's an example.
Q (By Mr. Devlin) Are you aware of other ways to do time-division multiplexing that don't involve collision avoidance?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Yes. I think there are other techniques.
Q (By Mr. Devlin) Can you tell me an example?
A Well, there are pulling strategies. For example, a lower, I think is one of them, in which you have multiple sources that try to access a shared medium, but they are only given permission if they receive a token which they pick up.
So that would be an example of one.
Q That does not use collision avoidance?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Well, it depends on what you mean by collision avoidance. Certainly using the token avoids the incident of a collision.
Q (By Mr. Devlin) Are there any examples of time-division multiplexing, that you're aware of, where collisions can take place?
MR. WERDEGAR: Objection. Form.

THE DEPONENT: Where collisions can take place?
Q (By Mr. Devlin) Uh-huh.
A Yes.
Q Can you give me an example of one of those types of time-division multiplexing techniques?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: There are techniques where one or more sources -- excuse me -- two or more sources can try to access a bus, and they do this simultaneously, and a collision, in fact, does take place. They gather a number of techniques that detect that a collision has occurred, and then they back off a random amount of time and reattempt to access the bus.
Q (By Mr. Devlin) Is there a specific example of that, that you have in mind?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: No.
Q (By Mr. Devlin) No. Okay.
Is it like Ethernet works?
MR. WERDEGAR: Objection. Form.
Q (By Mr. Devlin) My question, just in case it wasn't clear because I said it fast, was: Do you know how Ethernet works, Dr. Siller?
A No. I don't know the details of how Ethernet

confirming, when you said "network administrator," you meant an actual person whose job it is to be a network --

A Right.

Q -- administrator.

That's what you meant?

A Yeah.

Q Okay. What's a network clock framing period?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Well, there are subframes. And if there are subframes, there are presumably frames.

Q (By Mr. Devlin) Uh-huh.

A And since these are delineated in time between the acknowledged here and the claims terms, I think that explains it.

Q Does this suggest to you that the user could do the division of the period into frames and subframes and time slots?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: I'm not sure I have an expert opinion on that.

Q (By Mr. Devlin) Okay. In any case, there's -- there's nothing in that phrase that we just read or anything else that you can think of that states

that the network timing means actually does that
division, right?
A Right.
Q Okay.
A In fact, I believe that to be the structure
that count- -- is a counterpart to the patent claim
terms you had me read.
Q When you say the structure -- now, let's talk
about that.
I'm looking at the chart again. I'm sorry.
A That's sorry.
Q And now I'm carrying over -- unfortunately,
this thing goes from A-23 to A-24, and on A-24 you see
the structure.
A Oh, fine.
Q Right?
A Yeah.
Q Okay. And so the structure that you designate
is the network timing and control processor 12, right?
A Correct.
Q Okay. And then you provide some citations
there.
A Yeah.
Q Can I ask you this: What exactly is the
structure that you are citing here? Is it just the

Q Uh-huh.
A -- in Figures No. 1 and 3. So it's not specific what within the master unit does that.
Q Right. It doesn't necessarily say that it's the ranging means within the master unit that does that. It's -- it could be something else in the master unit.
Is that fair?
MR. WERDEGAR: Objection. Form. Leading.
THE DEPONENT: That's a possible interpretation.
Q (By Mr. Devlin) Is that a fair statement, that something else in the master unit could perform that function; that is, transmitting the transmission time to each of the respective remote units?
MR. WERDEGAR: Objection. Form. Leading.
THE DEPONENT: I think that some of those capabilities are captured in the structure that we enumerate over here.
Q (By Mr. Devlin) I'm -- I'm with you there. But what I'm asking you is -- so the -- let's just start at the start again.
A Okay.
Q This text doesn't specify that this transmission from the master unit to each of the respective remote units is performed by the ranging

means, right?
A That's correct.
Q Okay. The master unit includes the ranging means.
A It does.
Q Okay. But there's other things in the master unit also, right?
A That's right.
Q Okay. And it could be something else in the master unit that performs that transmission function.
MR. WERDEGAR: Objection. Leading.
Q (By Mr. Devlin) Is that fair?
MR. WERDEGAR: Objection. Form.
THE DEPONENT: Yes, that's fair.
Q (By Mr. Devlin) Okay. Let's talk now about the function that you lay out -- oh, let me back up for a second.
So apart from this claim language that we have just been discussing, is there anywhere else in the patent -- so we have been talking about the basis for your opinion that this claim term is, in fact, subject to 112, 6, right?
A That's right.
Q And you just gave me this claim language as one of your bases, and we talked about it, right?

Q (By Mr. Devlin) Sure. And you haven't --
A So I haven't formed an opinion on every aspect.
Q Okay. You do agree with me, though, that the description in the patent indicated that time slots could be assigned dynamically?
MR. WERDEGAR: Objection. Form. Leading. Beyond the scope.
THE DEPONENT: I have read that in the description.
Q (By Mr. Devlin) Let me just make sure we are on the same page.
A Okay.
Q What we read in the description at column 2, lines 18 through 26 -- do you see that?
A Yeah.
Q -- indicates to you that time slots can be assigned dynamically.
Is the fair?
MR. WERDEGAR: Objection. Form. Leading. Beyond the scope of his expert designation.
THE DEPONENT: Well, the master unit is going to make a decision as to whether or not the requesting remote unit should use additional access slots. It doesn't say that they are allocated to them.

communication, for example, and there are several people using a network and you want to establish some users as taking precedence over other users so they have a different relative priority.

Q (By Mr. Devlin) What about priority in terms of one type of data versus another; do you ever have that type of priority?

A Yeah. That -- that could occur as well.

Q And could you give me an example of that?

A I don't think of a specific example; I think that maybe your words were sufficient. You have two data communication flows. There's a decision made somehow that one has a higher relative priority than another, and that's that.

Q Would it be possible for one type of application -- data associated with one type of application to be granted a higher priority than data associated with another application?

Would that be possible?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Yes. I think that would be possible.

Q (By Mr. Devlin) Were you dealing with any issues of priority in the late 1980s or early 1990s when this patent was in the patent office and when it was

associated with Application No. 1. To say that I set them or whomever would set them is not divulged here.

Q (By Mr. Devlin) So let me just confirm what you said.

This figure indicates that there can be priority bits associated with Application 1.

Is that a fair reading of it?

MR. WERDEGAR: Objection. Form. Objection. Leading. Beyond the scope.

THE DEPONENT: Yes.

Q (By Mr. Devlin) And then you could also have priority bits associated with Application 2, right?

MR. WERDEGAR: Same objections.

THE DEPONENT: Yes.

Q (By Mr. Devlin) And you could have -- excuse me. You could have priority bits associated with Application N.

MR. WERDEGAR: Same objections.

THE DEPONENT: Yes.

Q (By Mr. Devlin) And those priority bits could be different between Application 1 and Application 2.

Is that fair?

MR. WERDEGAR: Objection. Leading. Objection. Form. Beyond the scope.

THE DEPONENT: Well, it depends on how many

Exhibit 26

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP,)
)
Plaintiff,)
)
vs.) No. 2:05-cv-00443-TJW
)
COMCAST CORPORATION; COMCAST)
CABLE COMMUNICATIONS, LLC;)
AND COMCAST OF PLANO, LP,)
)
Defendants.)
______________________________)

Deposition of HARRY BIMS, Ph.D., EE, taken on behalf of Plaintiff, at 710 Sansome Street, San Francisco, California, beginning at 8:56 a.m. and ending at 6:02 p.m., on Friday, December 22, 2006, before GINA GLANTZ, Certified Shorthand Reporter No. 9795.

HARRY BIMS, Ph.D., EE,
having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. KOLODNEY:

Q Good morning -- is it Dr. Bims or Mr. Bims?

A Dr. Bims, yes.

Q Okay. Dr. Bims, my name is Larry Kolodney and I represent the plaintiff in this case, Rembrandt Technologies. And I'll be asking you a series of questions today. As you probably already understand, you're under oath and you need to answer your questions truthfully as though you were testifying in a court of law. Do you understand that?

A Yes.

Q Okay. Please state your name and address for the record.

A Harry Bims, 1314 Chilco Street, Menlo Park, California 94025.

Q And Dr. Bims, do you know why you're here today to testify?

A I'm here to testify based upon the request of Rembrandt, I believe.

Q Okay. Do you understand that you're here to

error-corrected?

MR. WERDEGAR: Objection to form.

THE WITNESS: There are some Reed-Solomon codes that operate on bytes, but Reed-Solomon codes are more general than that.

BY MR. KOLODNEY:

Q Is it true that Reed-Solomon codes, in general, work on a -- correct a unit of data that is larger than one bit?

MR. WERDEGAR: Objection to form.

THE WITNESS: So when you say "a unit of data," what are you referring to?

BY MR. KOLODNEY:

Q I'm referring to the concept that, in a Reed-Solomon code, a piece of data that's larger than one bit is corrected by the code rather than the code correcting individual bits that are erroneous.

A Well, the error-correction code itself does not correct data bits. It simply provides the information that is useful for the eventual correction of those errored bits.

Q Well, something on the receiver that is a Reed-Solomon decoder does that; right?

A Yeah. The purpose of a Reed-Solomon decoder would be to take advantage of the extra information

supplied by a Reed-Solomon encoder for the purposes of correcting errored bits.

Q And isn't it the case that, in a Reed-Solomon decoder, errors are corrected typically on a bytewise basis?

MR. WERDEGAR: Objection to form.

THE WITNESS: Yeah, I would say that there are a variety of implementations for a Reed-Solomon decoder, and that you do not necessarily have to decode Reed-Solomon code words on a byte-by-byte basis.

BY MR. KOLODNEY:

Q What's a Reed-Solomon code word?

A A Reed-Solomon code word is a concatenation of bits generated from a Reed-Solomon encoder.

Q And what is the significance of the size of the Reed-Solomon code word?

MR. WERDEGAR: Objection to form.

THE WITNESS: The significance of the size?

BY MR. KOLODNEY:

Q Well, let me ask you this. Is there a size of a code word associated with a given Reed-Solomon code?

MR. WERDEGAR: Objection to form.

THE WITNESS: Well, as I say, a Reed-Solomon code is a general concept relating to a fairly flexible algorithm, so there is no one particular size to a

A A layer is a decomposition of the communications protocol into a subset of functions that are provided by the protocol.

Q What's the value of decomposing a protocol into sets of functions that are associated with different layers?

MR. WERDEGAR: Objection to form.

THE WITNESS: Well, the value of doing such decomposition is that it reduces the complexity of the research and analysis and implementation of the communications protocol to decompose the functions into layers that can be updated without affecting the other layers.

BY MR. KOLODNEY:

Q Can a communications protocol exist in multiple layers at the same time?

A Yes. There are many examples of communications protocol standards that encompass multiple layers in the OSI protocol model.

Q Can you give me some of those examples?

A Okay. I would say that -- let's pick GPRS. The GPRS protocol standard encompasses physical layer functions, data link layer functions, and even network layer functions in the protocol.

Q Okay. How does one distinguish between the

Case 1:07-cv-00398-GMS Document 12-4 Filed 06/18/2007 Page 7 of 33

different layers when looking at a protocol to determine which functions belong in which layer --
MR. WERDEGAR: Object.
BY MR. KOLODNEY:
Q -- of the OSI seven-layer model?
MR. WERDEGAR: Objection to form.
THE WITNESS: Well, it's generally understood as to which functions go within which layer of the OSI protocol model.
BY MR. KOLODNEY:
Q Well, is there someplace where people look to find this general understanding? Is there an authoritative source for the definition of the different layers?
MR. WERDEGAR: Objection to form.
THE WITNESS: There's certainly places where one can go to get the definition of the OSI protocol layer. It's a pretty common terminology. And there are several places, textbooks, Web sites, et cetera, which describe it.
(Deposition Exhibit 2 marked.)
BY MR. KOLODNEY:
Q Showing you what's been marked as Exhibit 2, which is a paper by Hubert Zimmermann entitled "OSI Reference Model - The ISO Model of Architecture for Open

identified in the section 7, "Physical Layer," that I just read.

Q Okay. Do you think that the current understanding of the physical layer in the OSI reference model includes everything that you read in -- on page 430 of the Zimmermann paper and then some other things as well?

MR. WERDEGAR: Objection to form.

THE WITNESS: I'm not necessarily opposed to this paragraph as written.

BY MR. KOLODNEY:

Q Okay. So --

A But I do believe that, again, there are other elements that are not mentioned in this paragraph that I would include in the definition.

Q Okay. So you agree that, as presently understood, and as understood in the 1990s, the physical layer included at least the mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections (e.g., data circuits) between data link entities?

MR. WERDEGAR: Objection to form.

BY MR. KOLODNEY:

Q Would you agree with that?

MR. WERDEGAR: Objection to form. Objection.

Leading.

THE WITNESS: Yeah, I would say that at least those elements would be included in the physical layer.

BY MR. KOLODNEY:

Q Okay. Do you have an understanding of what is meant by functional and procedural characteristics to maintain -- establish, maintain, and release physical connections?

A Those are fairly vague terms, but I do have some sense of what they might mean.

Q What's your best understanding?

A Well, the -- my best understanding is that the functional and procedural characteristics are going beyond simply the physical, mechanical or electrical connectors, but going into certain algorithms that are implemented as characteristics of the physical layer.

Q Okay. Can you give me some examples of what you have in mind?

A Well, certain algorithms would include algorithms for timing recovery, for equalization, for error correction, you know, other signal-processing characteristics like that.

Q What does timing recovery mean?

A Timing recovery is a process that a receiver would go through to synchronize its timing information

history, so I didn't remember whether or not there were changes since the original application.

Q Apart from the claims, the written description in this patent is the same as what you filed with the patent office, isn't it?

A I'd have to read it, the file history, to know whether or not there were any changes since the initial application.

Q Well, we can find out whether there were any changes. But I'm going to ask you whether the patent application that you filed with the patent office that led to this patent was something that you agreed with in 1998 when you filed it.

A Yes, I believe that the invention was the -- was something I agreed with, yes.

Q And the description of how the invention worked in this patent was accurate, was it not?

A Of how the invention worked, yes.

Q I'd like you to turn your attention to column 8, line 5.

A Okay.

Q And read for me the first two sentences -- first three sentences of that paragraph.

A It says, "Data link layer (Layer 2) 408 looks the same for all protocols. In one embodiment, data

Case 2:05-cv-00433-TJW-CE Document 190-14 Filed 06/18/2007 Page 111 of 333

link layer 408 is implemented for inbound channels in device driver 304 with Reed-Solomon decoding of the inbound data packets, check-sum verification and packet identification."

Q Dr. Bims, did you or did you not, in the '911 patent, describe the data link layer as including Reed-Solomon decoding of inbound packets?

MR. WERDEGAR: Objection to form. Objection. Leading.

THE WITNESS: What I said here, and I'm looking word for word at what is written in this specification, is that in one embodiment, it is possible to do Reed-Solomon decoding of inbound packets, add in a data link layer in that embodiment.

BY MR. KOLODNEY:

Q So in the embodiment you were describing in this paragraph, in your patent, you describe the data link layer as including the Reed-Solomon decoding of inbound packets, did you not?

MR. WERDEGAR: Objection to form. Objection. Leading. And if you need --

THE WITNESS: I haven't even read the patent.

MR. WERDEGAR: If you need to take time -- if you want to review the patent before answering the question, you should feel welcome to refresh yourself.

THE WITNESS: Okay, I mean, you know, we just grabbed a sentence here. It's been -- what? -- six -- five years or -- when did I submit it? Eight years ago. But I know that that text that we just read refers to figures that are elsewhere in the specification and --

BY MR. KOLODNEY:

Q Well, I'll tell you what. You read this, and tell me when you've read enough of it to explain the three sentences that we just read into the record, please. Take as much time as you need.

A Okay.

Q All right?

A Um-hmm.

Q So first of all, the data link layer that's referred to in column 8 of your patent is the data link layer of the OSI model; right?

A Yes.

Q That's what it says in the previous column --

A Right.

Q -- okay? And the thing you're describing in column 8 is elements of a receiver; right?

A Um-hmm.

Q And the receiver in layer 2, in the data link layer, is using a Reed-Solomon decoder --

A Um-hmm.

into a new area. You don't think it's an appropriate time to take a lunch break?

MR. KOLODNEY: Sure.

MR. WERDEGAR: Thanks.

THE VIDEOGRAPHER: We're now going off the video record. The time is 12:29 p.m.

(Lunch recess.)

THE VIDEOGRAPHER: We are now back on the video record. The time is 1:31 p.m.

BY MR. KOLODNEY:

Q Dr. Bims, was the purpose of the Reed-Solomon decoder in your '911 patent to detect and correct errors that can occur in the physical layer?

A Yes.

Q And you mentioned that some of your earlier work involved development of trellis codes; is that correct?

A Yes.

Q And was the purpose of the trellis codes that you developed to detect and correct errors that could occur in the physical layer?

A The purpose, the main purpose was that, but that wasn't my invention, but that's what the trellis codes were doing.

Q In general, that's what trellis codes are used

Q Do you know what CDMA_ALOHA is?
A This is the first time I've heard of CDMA_ALOHA.
Q Okay. I'd like you to read the first two sentences of the abstract aloud, please.
A "In this paper, we analyze the performance of a CDMA_ALOHA scheme by considering the packet collision probability as well as the bit error probability. And we propose a new CDMA_ALOHA/FEC scheme which uses a block FEC code in the data link layer for correcting bit errors of the received packets. By analyzing the proposed scheme, we show that the system throughput closely relates to the bit error rates. The results also show that the system throughput can be significantly improved by using the FEC coding, approaching to the value which is competitive with the error-free channel."
Q What's FEC coding?
MR. WERDEGAR: Objection to form.
THE WITNESS: FEC code is a forward error-correction code.
BY MR. KOLODNEY:
Q And what are some examples of forward error-correction codes?
A I would say forward error-correction codes

would be, say, a Hamming code.
Q How about a Reed-Solomon code?
A Yeah, BCH codes, Reed-Solomon codes would be FEC codes.
Q Would a trellis code be an FEC code?
A Yeah, I would say so.
Q Okay. And what you just read in the abstract is a description of using a block forward error-correction code in the data link layer for correcting bit errors; is that not the case?
A That's --
MR. WERDEGAR: Objection. Objection to form. Objection. Leading.
THE WITNESS: Yes, that's true.
BY MR. KOLODNEY:
Q So whatever you think link layer means, the authors of this article clearly understood error-correction coding to belong in the link layer; isn't that correct?
MR. WERDEGAR: Objection to form. Objection. Leading.
And if you feel you want to read the rest of the article before you comment on -- comment on it, you're welcome to take the time to do so.
THE WITNESS: Okay, well, when I read those

modulation?
A I would say that's a mischaracterization of that term.
Q What's wrong with it?
A Well, I guess there are a number of things wrong with that explanation. First of all, you're talking about a process selected by a process, which implies that you have to have some sort of software routine running on an operating system to do the selection, and that's not necessarily the case for negotiation.
Q Well, where do you see process meaning software?
A The word "process" is typically used in the context of a software program running at run time.
Q What if process is simply meant to mean a method or a protocol?
MR. WERDEGAR: Objection to form.
THE WITNESS: Well, I mean, we could hypothetically come up with all sorts of definitions for terms. I'm just giving you my explanation of, when I read the construction, why I felt it wasn't the most accurate one.
BY MR. KOLODNEY:
Q Okay. Let me then rephrase it and say, would

you agree that a negotiated physical modulation is selected by a method permitting two modems supporting different physical layer modulations to agree on a physical layer modulation?

A Well, again, I guess that's a truncated recitation of the fullness of the construction.

Q Well, would you agree that it's accurate, as far as it goes?

A I would agree that it's an abbreviation of the correct definition.

Q Okay. And what if I added to that that one modem has to present one or more options to the other modem and the other modem has to choose, from among the presented options, which ones it wants to use; would that be correct?

A Well, again, as was stated here on -- in this -- in the file history on page 6, the answering modem has to be incapable of receiv- -- executing the command presented to it by the calling modem for there to be negotiation. And then, secondly, this has to take place at run time.

Q Okay. And would you agree that if the two modems did not support all the same physical layer modulations, that the calling modem could present to the answering modem a physical layer modulation that the

Case 1:07-cv-00498-GMS Document 12-4 Filed 06/18/2007 Page 18 of 33

MR. WERDEGAR: Objection to form. Objection. Leading.

BY MR. KOLODNEY:

Q That's what the second sentence means?

A Well, it's based upon the negotiated physical layer connection, so it's not just independent of that.

Q Okay. But it does -- it achieves the error-corrected connection by presetting the XID phase parameters to default values; right?

MR. WERDEGAR: Objection to form. Objection. Leading.

THE WITNESS: And -- yes, those values are based upon what's negotiated at the physical layer.

BY MR. KOLODNEY:

Q Okay. And then those values are used to automatically form a link layer connection; right? That's what the third sentence says?

MR. WERDEGAR: Objection to form. Objection. Leading.

THE WITNESS: It -- the third sentence says that a link layer connection is immediately established once the physical layer modulation has been negotiated.

BY MR. KOLODNEY:

Q Because the XID phase parameters are set to default values, so there's no need to negotiate them;

BY MR. KOLODNEY:

Q No, but you've said that, although the structures that are specified here are not all necessary to perform the functions, somewhere in this litany of structures, we can find the necessary structure. That's what you're saying, isn't it?

A No, I'm not saying that.

Q Well, you are saying that what's listed here is more than is necessary to perform the recited function; right?

A Yeah, I could -- for example, I've already said that I could, for example, eliminate Figure 8 from what I believe are the absolutely required structural elements.

Q How about Figure 9?

A Within Figure 9, I would specifically point out on Figure 9 itself the structural elements 114, 124, 120, and 124.

Q And what about those structural elements would you point out?

A What about them?

Q You think those structural elements are necessary to perform the function?

A Yes.

Q Okay. And those are pieces of hardware; right?

Case 2:07-cv-00443-TJW-CE Document 91-14 Filed 10/18/2007 Page 20 of 33

A Yes.
Q Okay. Is there any hardware listed in Figures 4 through 7?
A Let's see, Figures 4 through 7, I believe, are flowcharts. Yes, they are all flowcharts.
Q Are all the steps in Figures 4 through 7 necessary to perform the function of the means for establishing a physical layer connection limitation?
A The way I would read this, Figures 4 and 5 are necessary structures for performing the function as a collection, and then Figures 6 and 7 are also structures, alternate structures, that perform the function together, along with Figure 9 structures I pointed out.
Q So it's not accurate to say, then, that you need all of Figures 4, 5, 6, 7 and 9 in order to be the corresponding structure to this limitation; right?
A Well, I guess my opinion here is that Figures 4 and 5, in combination with the structural elements that I outlined on Figure 9, represent the necessary structures for performing the function. And Figures 6 and 7, in combination with the structural elements that I mentioned before on Figure 9, would be also an alternate set of structures for performing the function.
Q Okay. So just to be clear, the position you're

Q Okay.
A And in that case, I'm not sure what would happen.
Q But if it generated something other than a 1680-hertz response, it would be able to establish a connection; right?
A The other parts of the flowchart would be intact, so --
Q And that would be a negotiated physical layer -- that would be a physical layer connection based on a negotiated physical layer modulation, would it not?
MR. WERDEGAR: Objection to form. Leading.
THE WITNESS: In the scenario where 1680 -- 1680-hertz, question mark, is false, under that condition, then the rest of the flowchart would implement a negotiated physical layer modulation.
BY MR. KOLODNEY:
Q So therefore, element 61 is not necessary for the establishment of a physical layer connection based on a negotiated physical layer modulation; correct?
A One would not need 61 to do that.
Q Do you want to modify your position on what the elements of Figures 4 through 7 are that are the corresponding structure to this limitation?
A Well, it appears that, in addition to the other

limitations that I put forth, that on Figure 4, that the detection of ANSqck would actually not be required to perform a negotiated physical layer modulation.

Q Is that it?

A Well, I'm looking at Figure 5. Figure 5 is the answer modem flowchart. I would say that on Figure 5, block 71 --

Q Is necessary or is not necessary?

A Let me think clearly here.

Q In fact, this whole flowchart of Figure 5 only happens if box 61 in Figure 4 happens on the transmitting modem; isn't that the case?

A I wouldn't say that.

Q Well, certainly box 71 corresponds to box 61, doesn't it? So if you're not going to do box 61, you're also not going to do box 71 or box 72 or box 73 in Figure 5, so those must be unnecessary, as well, to perform the function in this limitation; isn't that right?

MR. WERDEGAR: Objection to form. Leading.

MR. KOLODNEY: You know, you keep saying "leading." This is your witness. I have every right to lead him as far as I want to go.

MR. WERDEGAR: I have two objections under the Texas local rules and they're form and they're leading,

Q And 69.

A I would imagine in block 72, that a physical layer modulation is never negotiated, if V.34S is never received. So in that context, a physical layer modulation, it's possible, would never get negotiated.

Q So the answer to my question, which is that the only necessary structures in Figure 5 to perform the -- establishing a physical layer connection between said calling and said answer modems based on a negotiated physical layer modulation is boxes 69, 70 and 74; is that correct? If you had -- if you perform those three steps, you can perform the function required by that limitation of claim 6?

A That's correct.

Q Okay. Now, turning to the next limitation in -- the next means limitation in claim 6, which is "means for establishing said link layer connection based on said negotiated physical layer modulation," Comcast has identified Figures 8 to 9, column 12, line 55, to column 13, line 17; column 13, lines 34 to 41; column 13, line 55 to column 14, line 9. Do you agree with that identification of structure corresponding to the means for establishing said link layer limitation in claim 6?

A Again, I would -- turning to these figures, the

structure that's performing this function of establishing the link layer connection, would be in Figure 9 --

Q I just asked you whether you agreed with what is in Comcast's statement here about what the corresponding structure is.

MR. WERDEGAR: And he was answering your question, Counselor, and I'd appreciate it if you wouldn't interrupt the answer in mid answer.

MR. KOLODNEY: I asked him whether he agreed. I didn't ask him to identify the structures in the specification, which is what he was doing.

MR. WERDEGAR: Well, you can tell him -- you can ask the question again, but he's allowed -- he's entitled to answer the question without you interrupting him.

BY MR. KOLODNEY:

Q Do you or do you not agree with the identification of structure that is contained on page A-15 of the joint claim construction statement under the Comcast column?

A I do believe the structures that actually perform the function are contained within what's identified.

Q So there's more identified by Comcast than is

actually necessary to perform the function; is that correct?

A Yes.

Q Comcast's statement of structure doesn't actually point out exactly which structures are necessary to perform the function recited in the means for establishing limitation of claim 6; is that right?

A The structures are there in what's listed.

Q I know, but the listing doesn't actually identify which ones they are, does it?

A The structures, like I say, that actually perform the function are a subset of what's listed there.

Q But the subset is not identified on this list, is it?

MR. WERDEGAR: Objection to form. Leading.

THE WITNESS: You don't see it called out specifically.

BY MR. KOLODNEY:

Q So if -- someone reading this would not know, merely from reading it, what structures you had in mind, would they?

MR. WERDEGAR: Objection to form. Leading.

THE WITNESS: Well, again, I guess this column is Comcast's proposed constructions, you know, it

Case 2:07-cv-00493-CE Document 101-24 Filed 06/27/2007 Page 26 of 33

wasn't -- you know, I gave my opinions but it wasn't my proposed construction.

BY MR. KOLODNEY:

Q I'm not blaming you, but you agree that what's written here is not what you believe is actually the correct corresponding structure; right?

MR. WERDEGAR: Objection to form. Leading.

THE WITNESS: I would just say that what's here is more than what's actually performing the function.

THE VIDEOGRAPHER: Counsel, ten minutes.

MR. KOLODNEY: Okay.

Q Dr. Bims, have you read the '627 patent and understand what it discloses?

A Back to the '627. Yes, I've read the '627 patent.

Q Do you understand the claim language in the '627 patent?

MR. WERDEGAR: Objection to form.

THE WITNESS: I have read through it.

BY MR. KOLODNEY:

Q Do you believe you understand it?

MR. WERDEGAR: Objection to form.

THE WITNESS: From an engineer's perspective, I have some understanding of what the claims are saying.

BY MR. KOLODNEY:

memory elements that comprise the state to clock -- to sample and store a new value into it.

Q Okay. So in order for a trellis encoder to output a value, there needs to be a state change; right?

A For each new value that is output from the trellis encoder, there needs to be a new state change.

Q Okay.

THE VIDEOGRAPHER: Counsel, you have two minutes.

MR. KOLODNEY: Let's take a break.

THE VIDEOGRAPHER: Okay. This is the end of Videotape No. 3. We are now going off the video record. The time is 5:04 p.m.

(Interruption in the proceedings.)

THE VIDEOGRAPHER: This is the beginning of Videotape No. 4. We are now back on the video record. The time is 5:07 p.m.

BY MR. KOLODNEY:

Q So, Dr. Bims, under your construction of trellis-encoded channel symbol, the trellis-encoded channel symbol cannot be generated from multiple outputs of a trellis encoder; is that correct, multiple successive outputs of a trellis encoder?

A A trellis-encoded channel symbol is from one output of a trellis encoder, yes.

Q Under your construction --

A Yes.

Q -- of trellis encoder channels?

Now, your construction of a signal point is a single mapped point in a signal constellation; is that your construction of signal point?

A Yes.

Q Okay. Can a single mapped point in a signal constellation be a point in a one-dimensional signal constellation?

A Yes.

Q Are you familiar with VSB?

A Vestigial sideband?

Q Yes.

A Yes.

Q Does VSB have a one-dimensional signal point constellation?

A You can think of it in that context if you want.

Q That's a acceptable usage of the term "signal point" and "constellation"?

A Yes.

Q Now, you've been identified as having an opinion on the meaning of the -- sorry, I missed one. Do you have an opinion about the meaning of distributed

A Some have.
Q Okay. Do you agree that you could implement the Viterbi decoders described in this patent in a single software program that, through the use of indirect addressing of multiple arrays within memory, would serve to provide the function of the multiple trellis encoders disclosed in Figure 4 of the patent?
MR. WERDEGAR: Objection. Beyond the scope of his expert designation.
BY MR. KOLODNEY:
Q Do you think that's within the skill in the art?
A It's possible. It's possible.
Q Is it within the skill of a person of ordinary skill in the art to do that?
A I'm sure a person of ordinary skill in the art, if pressed, could implement such a thing.
Q After reading this patent?
A Yes.
Q Okay. And there's certainly no ambiguity that the patent is teaching that that's an alternative way to implement the invention; right?
MR. WERDEGAR: Objection. Beyond the scope, leading, form.
THE WITNESS: I would say that this is an

embodiment of one way of implementing what it's talking about here.

BY MR. KOLODNEY:

Q So implementing the Viterbi decoders with a single program routine is one embodiment of the invention of the '627 patent; right?

MR. WERDEGAR: Objection. Beyond the scope.

THE WITNESS: At least that's what's presented in this column.

BY MR. KOLODNEY:

Q Okay. Now, on the means for deinterleaving limitation in claim 9 of the '627 patent, if you turn to page A-5 of the -- I forget what exhibit number it is -- the first amended joint claim construction and prehearing statement. What exhibit is that?

A 13.

Q 13. Okay. Look at page A-5 of Exhibit 13. You see there the Comcast position on the function and structure corresponding to the means for deinterleaving limitation of claim 9?

A Yes.

Q Okay. And have you reviewed this prior to today?

A Yes, I have.

Q And did you agree that all of the structures

identified in -- by Comcast as being the corresponding structure are necessary to perform the function recited in this means limitation?

A Well, there were some structural elements that I thought were not absolutely required.

Q Which ones were those?

A Looking at block 431 --

Q Um-hmm.

A -- is not required for deinterleaving of the interleaved signal points.

Q Anything else?

A And that appears to be all.

Q What does deinterleaving mean?

A Deinterleaving means that it's a process that reverses the process of interleaving.

Q Would you agree that any structure that reversed the interleaving process that was performed in the transmitter, in Figure 3, would be sufficient to perform the function of deinterleaving required by the means for the deinterleaving limitation of claim 9?

MR. WERDEGAR: Objection to form. Leading.

THE WITNESS: Well, the claim 9 is talking specifically about interleaved signal points, so whatever deinterleaving is going on would have to be deinterleaving, specifically the interleaved signal

points.
BY MR. KOLODNEY:
Q So once again, here, you believe that Comcast has identified more structure than was necessary to perform the function recited in the claim -- in the means-plus-function claim limitation; is that correct?
A Yes. I think I mentioned block 431.
Q Did you point that out to Comcast when you reviewed this document the first time?
A I did mention to Comcast, when I saw this joint claim construction document, about block 431.
Q Did you review this document before it was filed with the court on November 14th, 2006?
A I did look through it.
Q And did you point out to Comcast that they identified too much structure as corresponding to the means for deinterleaving in claim 9 of the '627 patent?
A I disclosed that to them after this document was filed.
Q Well, why didn't you disclose it before it was filed?
A When I read through this element, I think I overlooked 431.
Q And similarly, with respect to the means limitations of the '631 patent that you now say

each time -- each clock cycle by 315; does that sound right to you?

A Yes, it does.

Q Okay. Those 9 bits are used to generate one channel symbol in the system; right?

A Yes, that's correct.

Q Okay. So each channel symbol in the system corresponds to these 9-bit chunks that are spit out by the serial-to-parallel converter each time there's a clock tick?

A Those 9 bits are used in generating that symbol.

Q So the channel symbol, in essence, represents a coded version of those 9 bits; is that correct?

MR. WERDEGAR: Objection to form. Leading.

(Interruption in the proceedings.)

THE WITNESS: So those 9 bits are run through a variety of elements here before the output 325.

BY MR. KOLODNEY:

Q Right. But each channel symbol on line 325 corresponds to that set of bits that are spit out by the serial-to-parallel converter each time it's triggered by the clock signal; right, by the symbol clock?

A It's a function of those 9 bits, among other things, yes.

Exhibit 27

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address : COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

07/249,450 09/26/88 KING J 2289-122

JOSEPH C. SULLIVAN
711 THIRD AVENUE
NEW YORK, NY 10017

HSU,A

263

11

10/18/89

☐ This application has been examined ☒ Responsive to communication filed on 9-5-89 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), ______ days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☒ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice re Patent Drawing, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, Form PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ ______

Part II SUMMARY OF ACTION

1. ☒ Claims 1-18 are pending in the application.

   Of the above, claims ______ are withdrawn from consideration.

2. ☒ Claims 2-4 have been cancelled.
3. ☐ Claims ______ are allowed.
4. ☒ Claims 1, 5-18 are rejected.
5. ☐ Claims ______ are objected to.
6. ☐ Claims ______ are subject to restriction or election requirement.
7. ☒ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on ______. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable. ☐ not acceptable (see explanation or Notice re Patent Drawing, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on ______ has (have) been ☐ approved by the examiner. ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed on ______, has been ☐ approved. ☐ disapproved (see explanation).
12. ☐ Acknowledgment is made of the claim for priority under U.S.C. 119. The certified copy has ☐ been received ☐ not been received ☐ been filed in parent application, serial no. ______ ; filed on ______.
13. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

PTOL-326 (Rev. 6-88)

Serial No. 249,450 -2-

Art Unit 263

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification is objected to under 35 U.S.C. 112, first paragraph, as failing to provide an enabling disclosure of the invention.

In the specification, it is unclear as to what "half duplex polled protocols" and "baseband regenerative modulation" are. It would be helpful for the applicant to supply prior art which does the teaching of the above if they are well known in the art.

2. Claims 6-13, 16 & 18 are rejected under 35 U.S.C. 112, first paragraph, for the reasons set forth in the above objection to the specification.

3. Claims 1, 5-14, 17 & 18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claims 1, 13 & 14, "said time slots", each lacks antecedent basis.

In claims 8-10, it is unclear as to what operating parameters refer to. Are they referring to timing signals?

In claim 10, it is unclear as to how operating parameters are indexed and advanced.

In claim 12, it is unclear as to how communication is encoded using baseband regenerative modulation.

In claim 14, line 3, "said reservation request bits" should be recited as "said reservation request bit".

In claim 18, line 2, "the aggregate port rate" lacks antecedent basis.

Also, for the apparatus claims, it is unclear as to where the claimed elements are located and how the claimed elements are connected to one another; specifically, the master network timing means, ranging means, reservation request generator, reservation request processor and means for calculating clock drifts.

4. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.
>
> Subject matter developed by another person, which qualifies as prior art only under subsection (f) and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

5. Claims 1, 7, 11, 13-18 are rejected under 35 U.S.C. 103 as being unpatentable over Sperlich.

Sperlich discloses a communication network

comprising a master unit and a plurality of remote units wherein the master unit including a timing means which divides period into time slots and a ranging means which calculates transmission time as in claims 1, 13, 14, 17 & 18. He also discloses a method for a plurality of remote units to communicate with a master unit utilizing the above claimed elements as in claims 15 & 16. But he fails to disclose the execution of application program by each of the remote units as in claims 1, 13 & 15. The execution of application program by remote unit in a communication network are well known in the art. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use remote unit to execute application program to communicate with the master unit since the communication between master unit and remote unit by the execution of application program for the information exchange is commonly used in communication network system. He also fails to disclose the data is in either analog or digital form as in claims 7 & 11.

The communication forms - analog and digital are well known in the art. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to utilize these communication forms in the network system since they are well known forms usable in communication network system.

6. Claims 5 & 6 are rejected under 35 U.S.C. 103 as being unpatentable over Sperlich in view of Akashi et al.

Sperlich fails to disclose a reservation request scheme from remote units to mater unit as in claims 5 & 6. Akashi et al from the same field of endeavor teaches the reservation request scheme from remote units to master unit for the purpose of requesting the reservation on the multiple access channel in response to the polling signal. Thus it would have been obvious to the person of ordinary skill in the art at the time of the invention to use the reservation request scheme in,Sperlich for the purpose of requesting the reservation on the multiple access channel in response to the polling signal.

7. Claims 8-10 are rejected under 35 U.S.C. 103 as being unpatentable over Sperlich and Akashi et al as applied to claims 1, 5-7, 17-18 above, and further in view of Betts et al.

Sperlich and Akashi et al. fail to disclose an equalizer and an automatic gain controller in the master as in claims 8-10. Betts et al. from the same field of endeavor teaches an equalizer and an automatic gain controller in master unit for the purpose of equalizing and adjusting the again of the received signals. Thus it would have been obvious to the person of ordinary skill in the art at the time of the invention to use the equalizer and the automatic gain controller in Sperlich for the purpose of equalizing and adjusting the gain of the received signals.

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Yamanaka et al. teach a method for synchronizing the times of a master clock provided in the master station and slave clocks provided in the slave stations in a data transmission system.

Aoki et al. teach a synchronization control capable of establishing synchronization without transmission of distance information between control and local earth stations in a TDMA satellite communication network.

Shinmyo teaches a multidirection multiplex communication system for improving the transmission efficiency by utilizing a demand assignment protocol.

Meuriche et al. teach an automatic gain control method and circuit for a time division multiple access receiver for receiving signals such as satellite transmissions or microwave beam signals.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alpus H. Hsu whose telephone number is (703) 557-6897.

Any inquiry of a general nature, or relating to the status of this application, should be directed to the Group receptionist whose telephone number is (703) 557-3321.

Douglas W. Olms

DOUGLAS W. OLMS
PRIMARY EXAMINER
GROUP 263

A.H.HSU:rf AHH
703-557-6897
10/13/89

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP—APART AND DISCARD CARBON

FORM PTO-892 (REV. 3-78) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

NOTICE OF REFERENCES CITED

SERIAL NO. 249450 | GROUP ART UNIT 263 | ATTACHMENT TO PAPER NUMBER 11

APPLICANT(S) King

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
	A	4644534	2/17/87	Sperlich	370	95	—
	B	4807259	2/21/89	Yamanaka et al.	370	85	5/18/87
	C	4800560	1/24/89	Aoki et al.	370	104	3/13/87
	D	4653049	3/24/87	Shinmyo	370	95	—
	E	4757502	7/12/88	Meuriche et al.	370	104	—
	F						
	G						
	H						
	I						
	J						
	K						

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG.	PP. SPEC.
	L								
	M								
	N								
	O								
	P								
	Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

R	
S	
T	
U	

EXAMINER: Alpus H. Hsu | DATE: 10/4/89

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

<u>Exhibit 28</u>

Case 2:07-cv-00398-TJW-CE Document 1-2 Filed 11/30/2007 Page 29 of 29

US006259911B1

(12) **United States Patent**
Bims et al.

(10) **Patent No.: US 6,259,911 B1**
(45) **Date of Patent: *Jul. 10, 2001**

(54) **NETWORK OPERATIONS CENTER HARDWARE AND SOFTWARE DESIGN**

(75) Inventors: **Harry V. Bims**, Palo Alto; **Donna Brown**, Campbell, both of CA (US)

(73) Assignee: **Wireless Access**, Santa Clara, CA (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/003,260**

(22) Filed: **Jan. 6, 1998**

(51) **Int. Cl.**[7] **H04Q 7/00**; H04Q 9/00

(52) **U.S. Cl.** **455/423**; 455/67.1; 455/67.4; 455/424; 455/425; 455/31.3

(58) **Field of Search** 455/31.3, 558, 455/115, 67.1–67.7, 226.1–226.4, 423, 38.1, 424; 379/93.31, 27, 29; 714/742; 370/466, 467, 241, 252, 313, 314; 340/825.44

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,875,038	*	10/1989	Siwiak et al.	340/825.44
4,977,399	*	12/1990	Price et al.	455/424
5,170,487	*	12/1992	Peek	455/45
5,451,839	*	9/1995	Rappaport et al.	375/224
5,619,550	*	4/1997	Averbuch et al.	379/5
5,742,590	*	4/1998	Lin et al.	370/252
5,754,946	*	5/1998	Cameron et al.	455/38.1
5,799,012	*	8/1998	Ayerst et al.	370/336
5,892,442	*	4/1999	Ozery	340/539
5,974,238	*	10/1999	Chase, Jr.	709/248

* cited by examiner

Primary Examiner—Nay Maung
Assistant Examiner—Temica M. Davis
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

A network operations center comprised of hardware and software that tests paging devices, such as two-way paging devices to determine that they conform to a specified protocol.

21 Claims, 15 Drawing Sheets

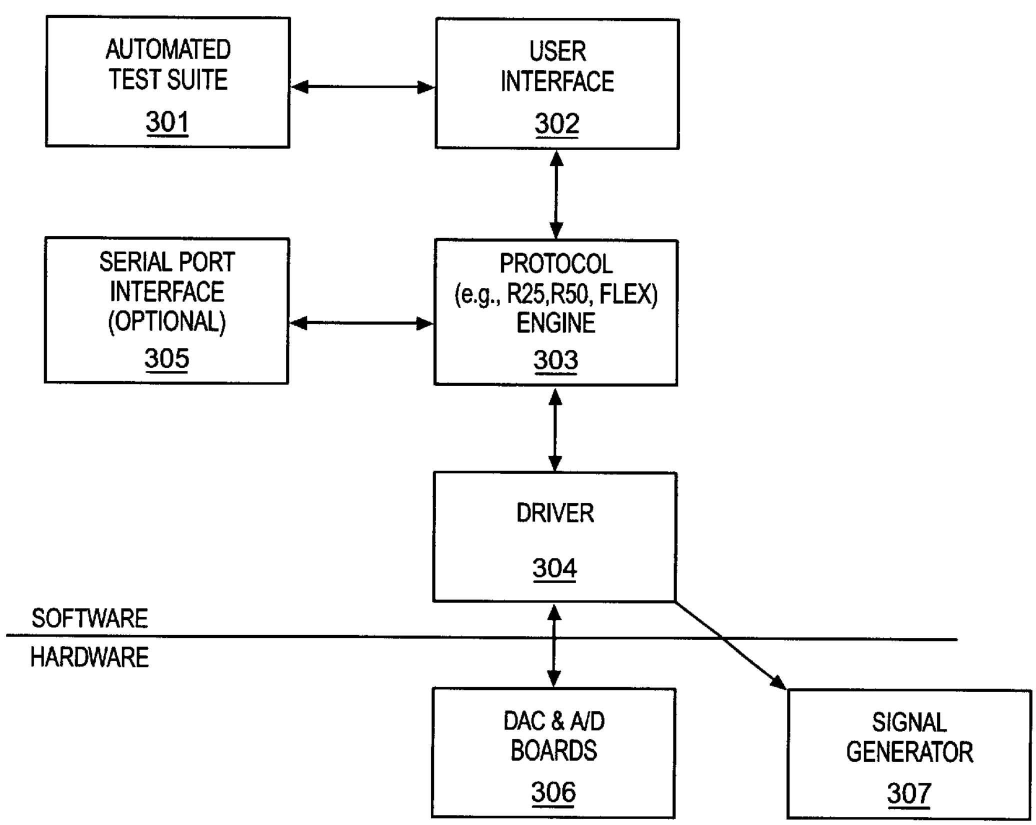
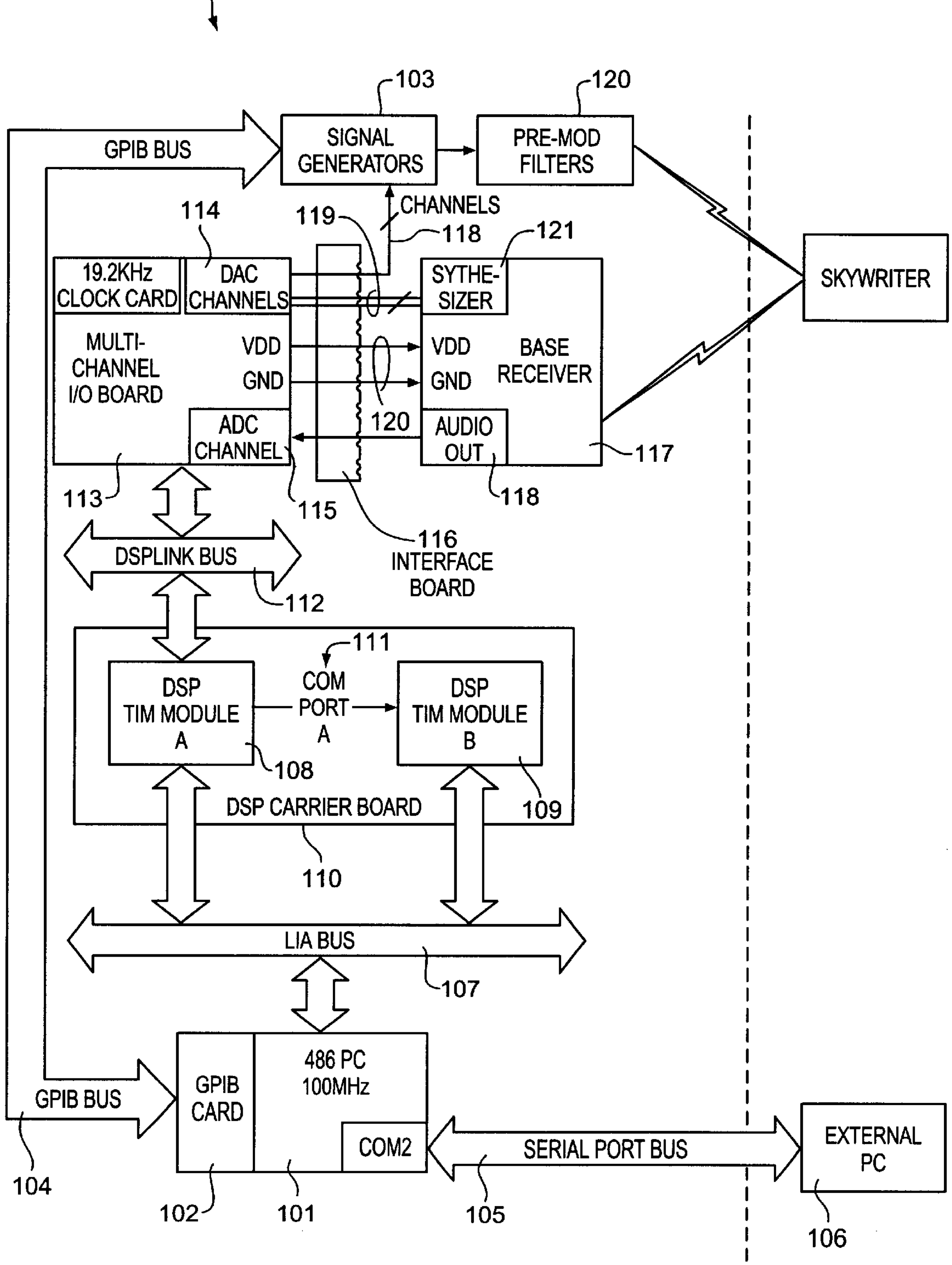


FIG. 1


100
103
120
GPIB BUS
SIGNAL GENERATORS
PRE-MOD FILTERS
CHANNELS
114
119
118
121
19.2KHz CLOCK CARD
DAC CHANNELS
SYTHE-SIZER
SKYWRITER
MULTI-CHANNEL I/O BOARD
VDD
GND
VDD
GND
BASE RECEIVER
ADC CHANNEL
120
AUDIO OUT
117
113
115
118
DSPLINK BUS
116
INTERFACE BOARD
112
111
DSP TIM MODULE A
COM PORT A
DSP TIM MODULE B
108
DSP CARRIER BOARD
109
110
LIA BUS
107
486 PC 100MHz
GPIB BUS
GPIB CARD
COM2
SERIAL PORT BUS
EXTERNAL PC
104
102
101
105
106

Case 2:07-cv-03398-SMB-JWD Document 128-6 Filed 06/28/2007 Page 29 of 29

FIG. 2

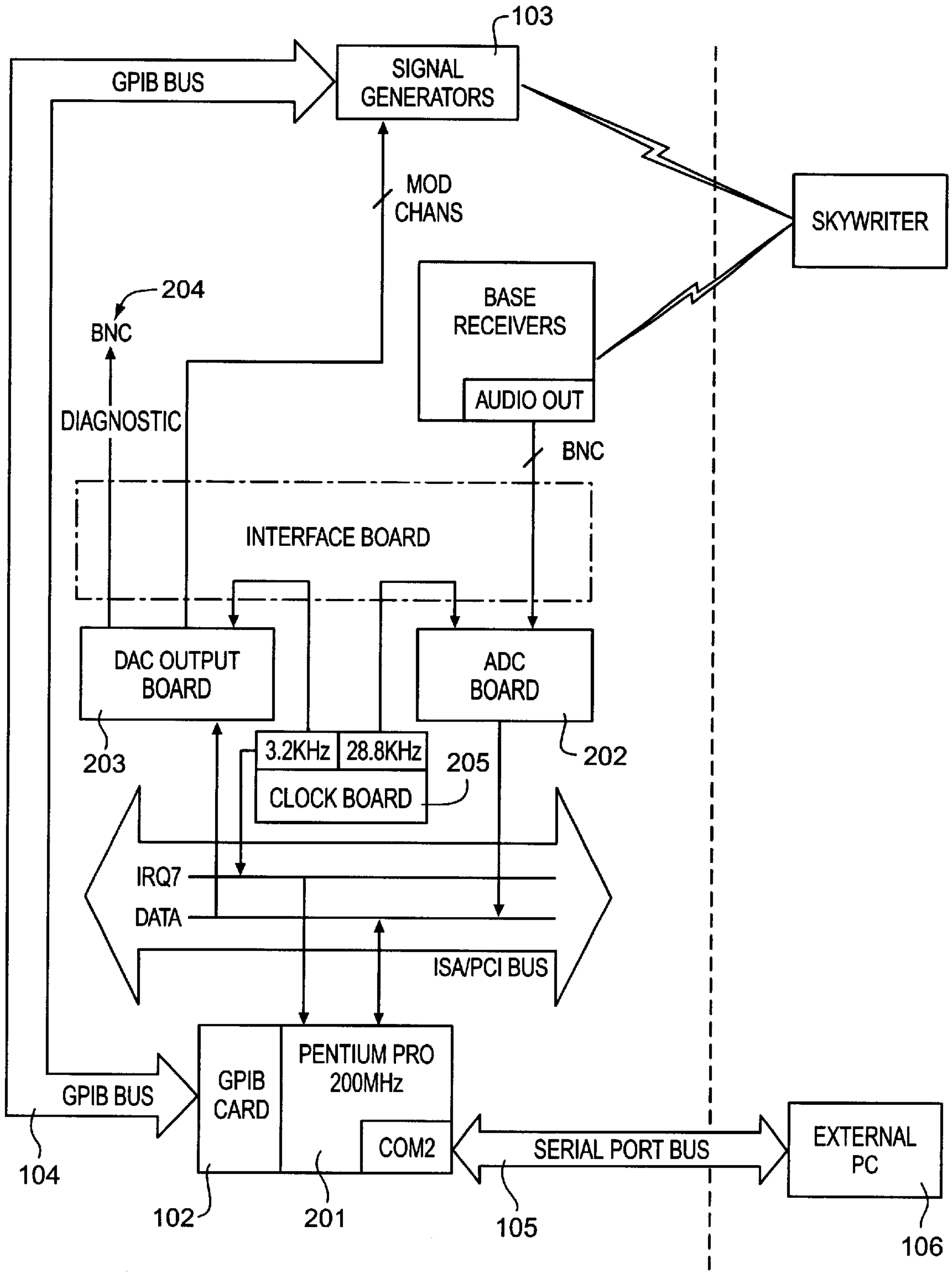


FIG. 3

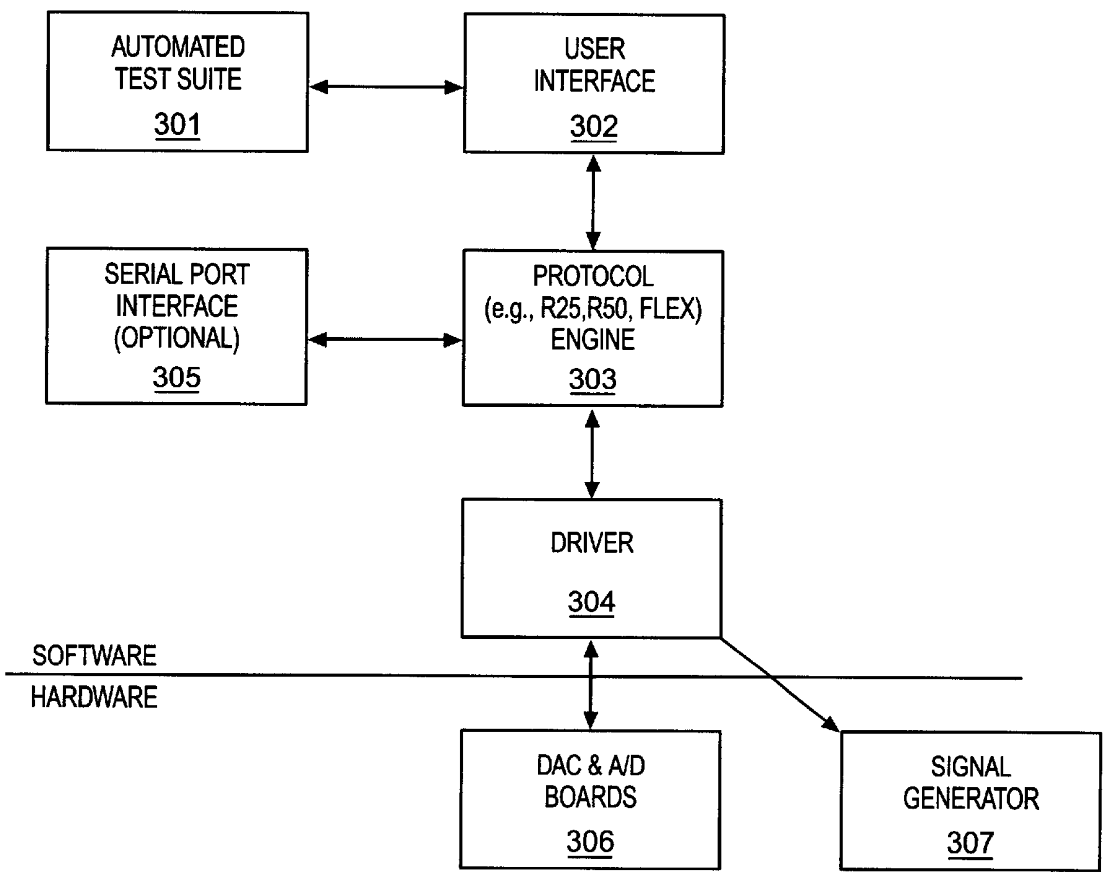

AUTOMATED TEST SUITE
301
USER INTERFACE
302
SERIAL PORT INTERFACE (OPTIONAL)
305
PROTOCOL (e.g., R25,R50, FLEX) ENGINE
303
DRIVER
304
SOFTWARE
HARDWARE
DAC & A/D BOARDS
306
SIGNAL GENERATOR
307

FIG. 4

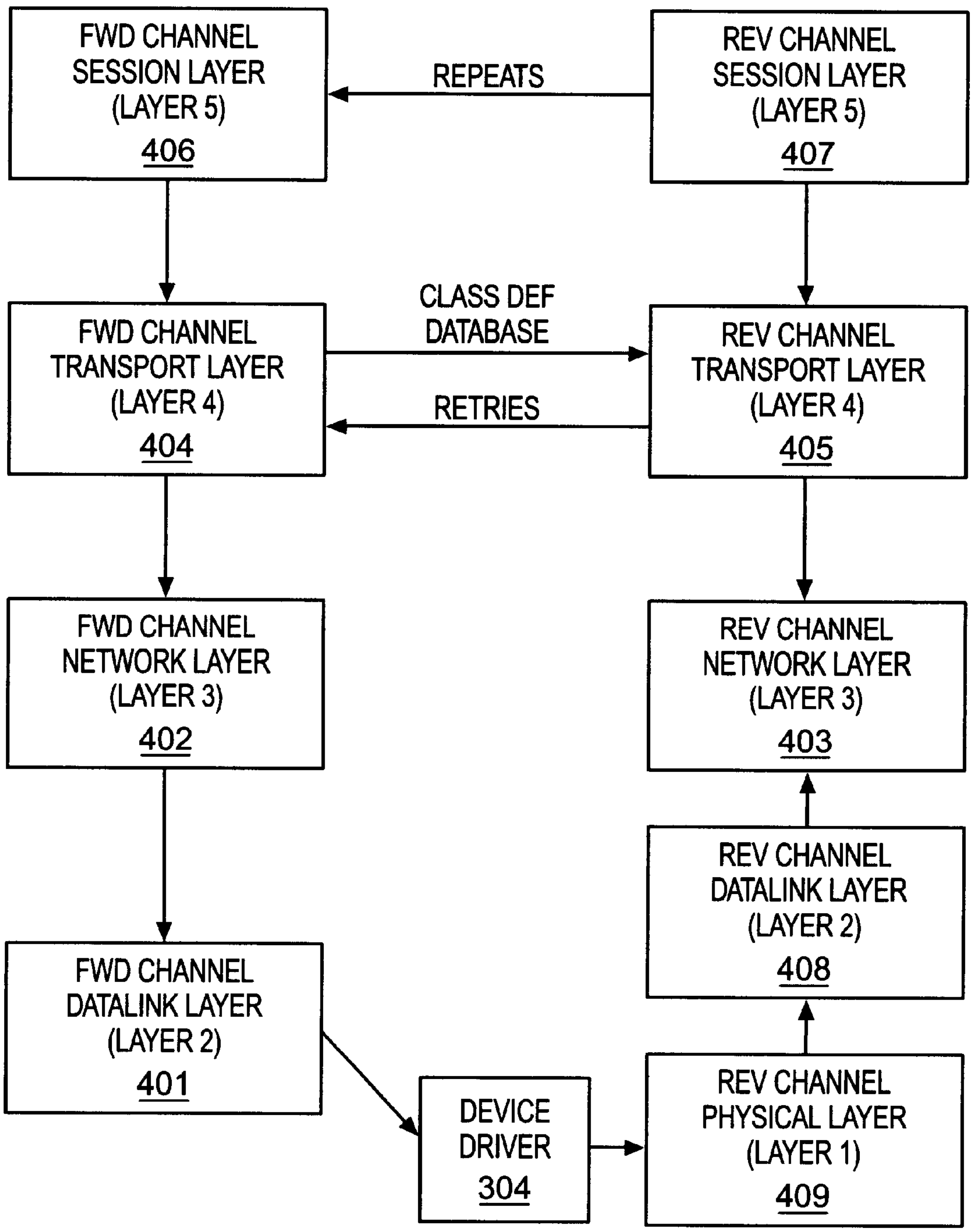
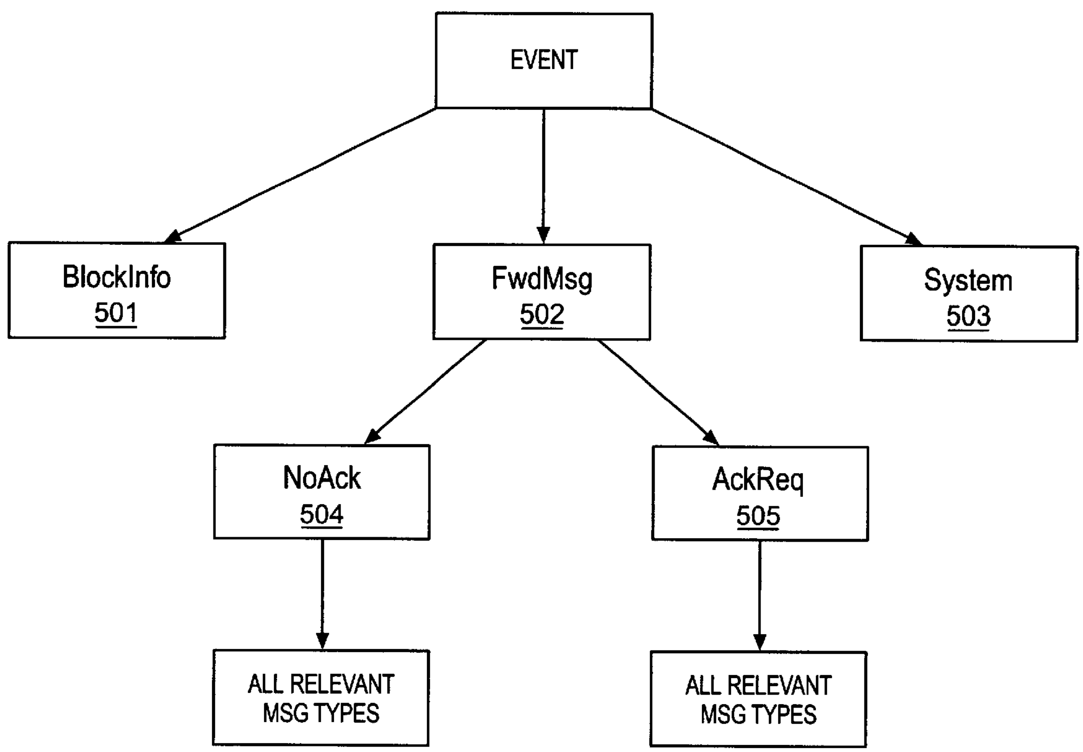

FWD CHANNEL SESSION LAYER (LAYER 5) 406
REPEATS
REV CHANNEL SESSION LAYER (LAYER 5) 407
CLASS DEF DATABASE
FWD CHANNEL TRANSPORT LAYER (LAYER 4) 404
RETRIES
REV CHANNEL TRANSPORT LAYER (LAYER 4) 405
FWD CHANNEL NETWORK LAYER (LAYER 3) 402
REV CHANNEL NETWORK LAYER (LAYER 3) 403
REV CHANNEL DATALINK LAYER (LAYER 2) 408
FWD CHANNEL DATALINK LAYER (LAYER 2) 401
DEVICE DRIVER 304
REV CHANNEL PHYSICAL LAYER (LAYER 1) 409

FIG. 5


EVENT
BlockInfo
501
FwdMsg
502
System
503
NoAck
504
AckReq
505
ALL RELEVANT MSG TYPES
ALL RELEVANT MSG TYPES

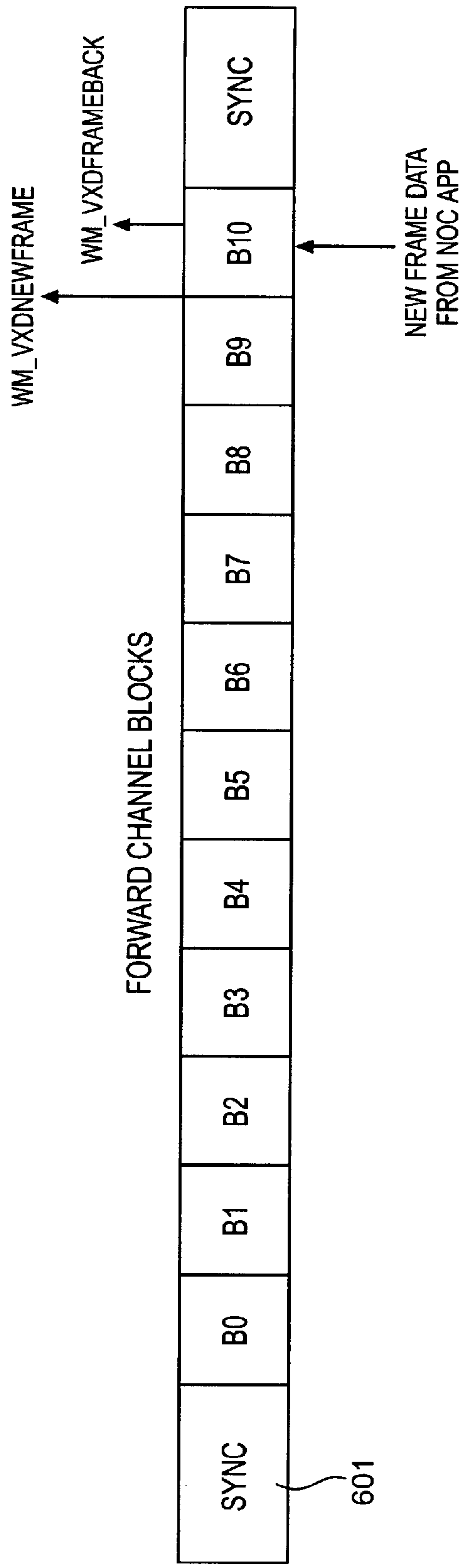

FORWARD CHANNEL BLOCKS
SYNC
B0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
SYNC
WM_VXDNEWFRAME
WM_VXDFRAMEBACK
NEW FRAME DATA FROM NOC APP
601

FIG. 6

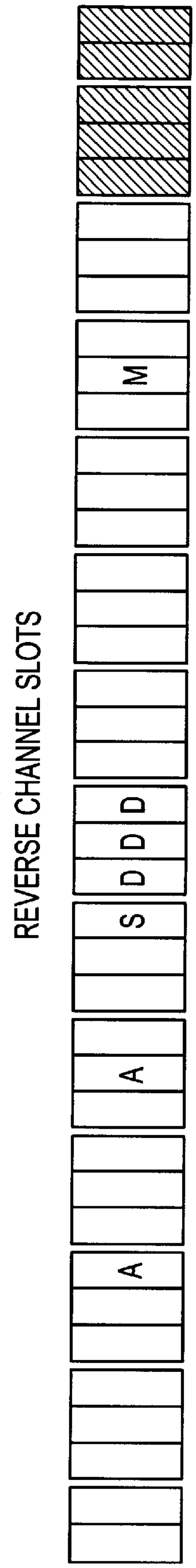


FIG. 7

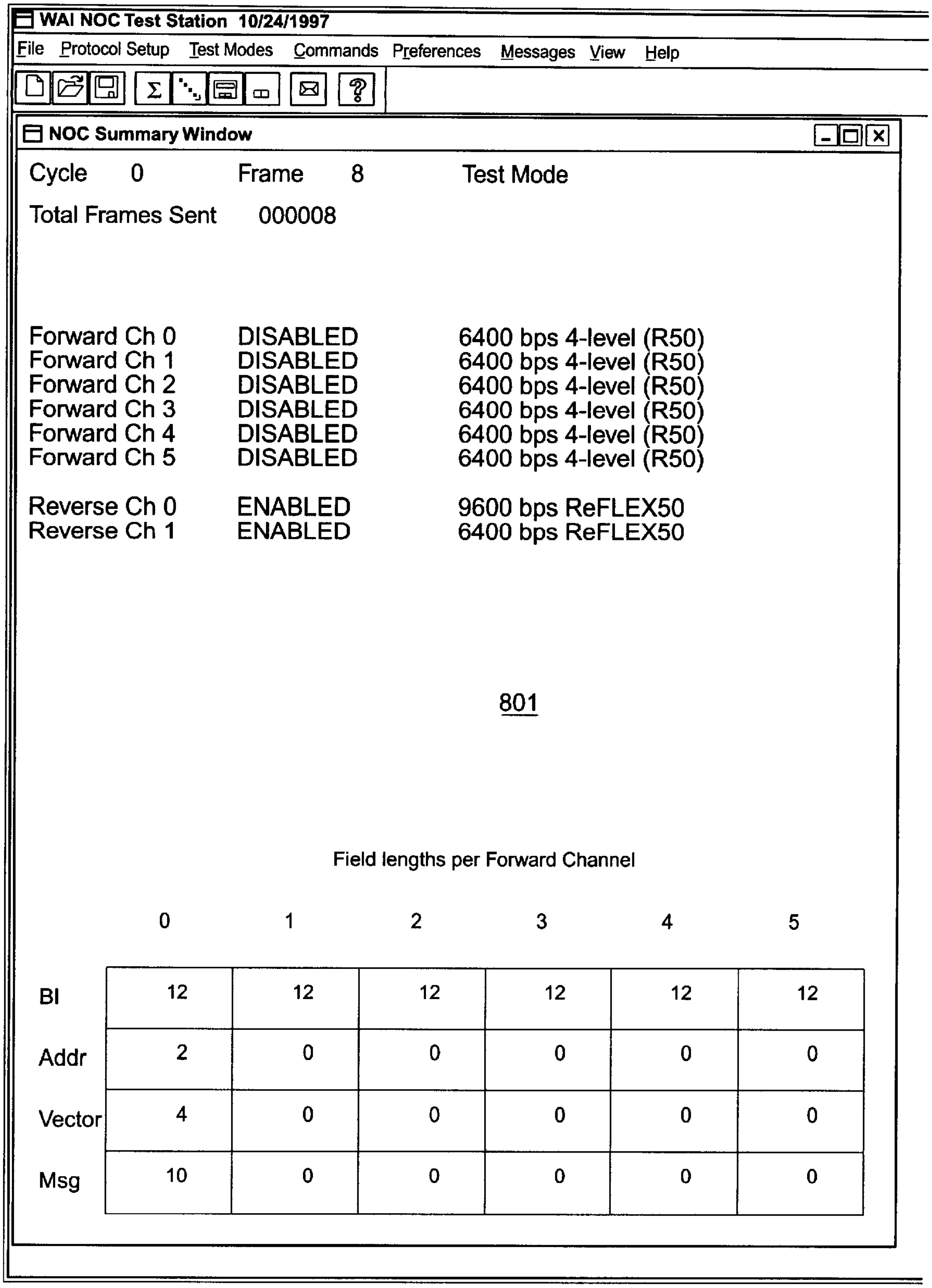

WAI NOC Test Station 10/24/1997
File Protocol Setup Test Modes Commands Preferences Messages View Help
NOC Summary Window
Cycle 0 Frame 8 Test Mode
Total Frames Sent 000008
Forward Ch 0 DISABLED 6400 bps 4-level (R50)
Forward Ch 1 DISABLED 6400 bps 4-level (R50)
Forward Ch 2 DISABLED 6400 bps 4-level (R50)
Forward Ch 3 DISABLED 6400 bps 4-level (R50)
Forward Ch 4 DISABLED 6400 bps 4-level (R50)
Forward Ch 5 DISABLED 6400 bps 4-level (R50)
Reverse Ch 0 ENABLED 9600 bps ReFLEX50
Reverse Ch 1 ENABLED 6400 bps ReFLEX50
801
Field lengths per Forward Channel
0 1 2 3 4 5
BI 12 12 12 12 12 12
Addr 2 0 0 0 0 0
Vector 4 0 0 0 0 0
Msg 10 0 0 0 0 0

FIG. 8A

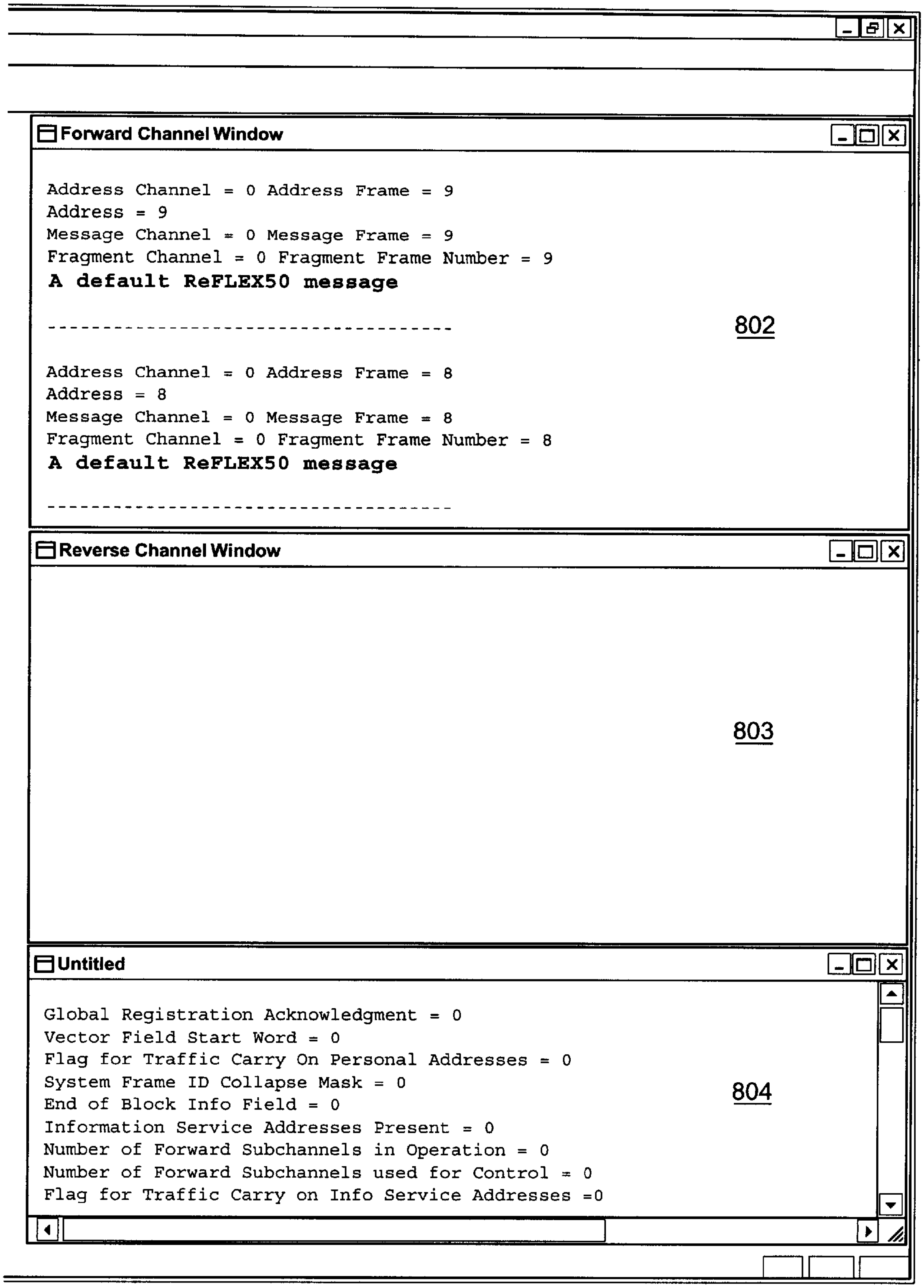

Forward Channel Window
Address Channel = 0 Address Frame = 9
Address = 9
Message Channel = 0 Message Frame = 9
Fragment Channel = 0 Fragment Frame Number = 9
A default ReFLEX50 message
802
Address Channel = 0 Address Frame = 8
Address = 8
Message Channel = 0 Message Frame = 8
Fragment Channel = 0 Fragment Frame Number = 8
A default ReFLEX50 message
Reverse Channel Window
803
Untitled
Global Registration Acknowledgment = 0
Vector Field Start Word = 0
Flag for Traffic Carry On Personal Addresses = 0
System Frame ID Collapse Mask = 0
End of Block Info Field = 0
Information Service Addresses Present = 0
Number of Forward Subchannels in Operation = 0
Number of Forward Subchannels used for Control = 0
Flag for Traffic Carry on Info Service Addresses =0
804

FIG. 8A-1

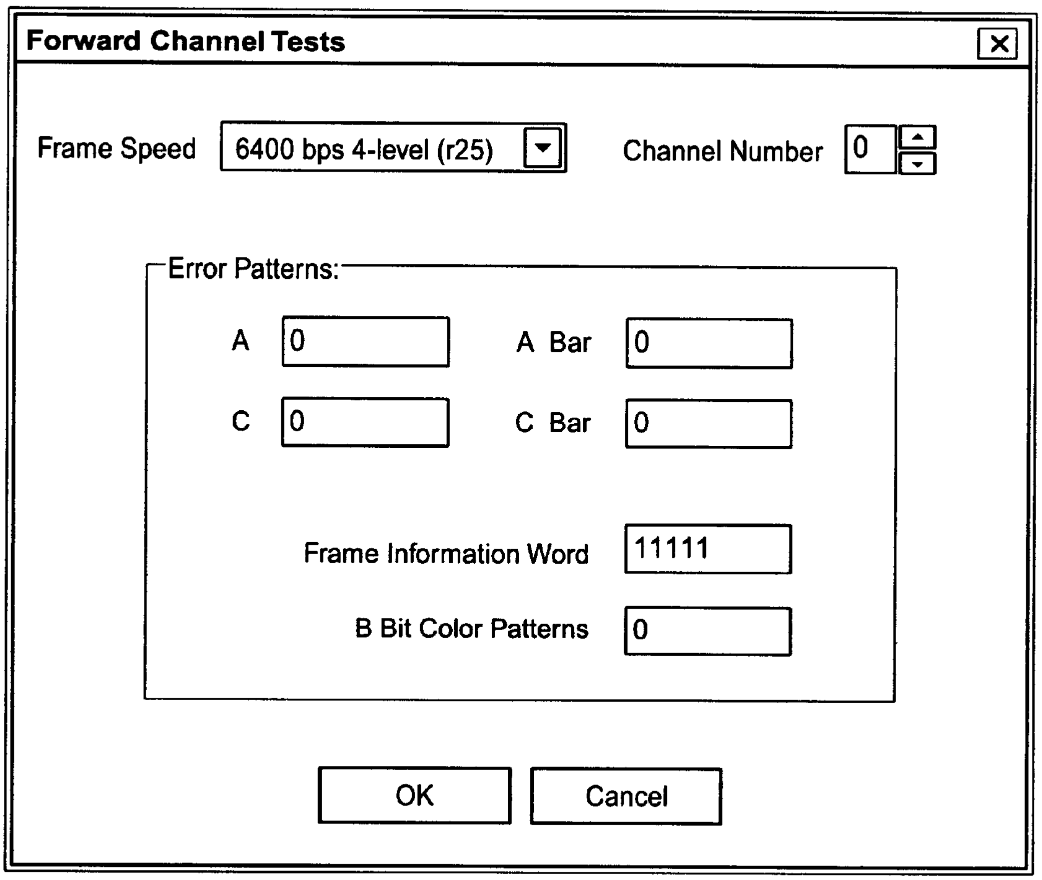

Forward Channel Tests
Frame Speed
6400 bps 4-level (r25)
Channel Number
0
Error Patterns:
A
0
A Bar
0
C
0
C Bar
0
Frame Information Word
11111
B Bit Color Patterns
0
OK
Cancel

FIG. 8B

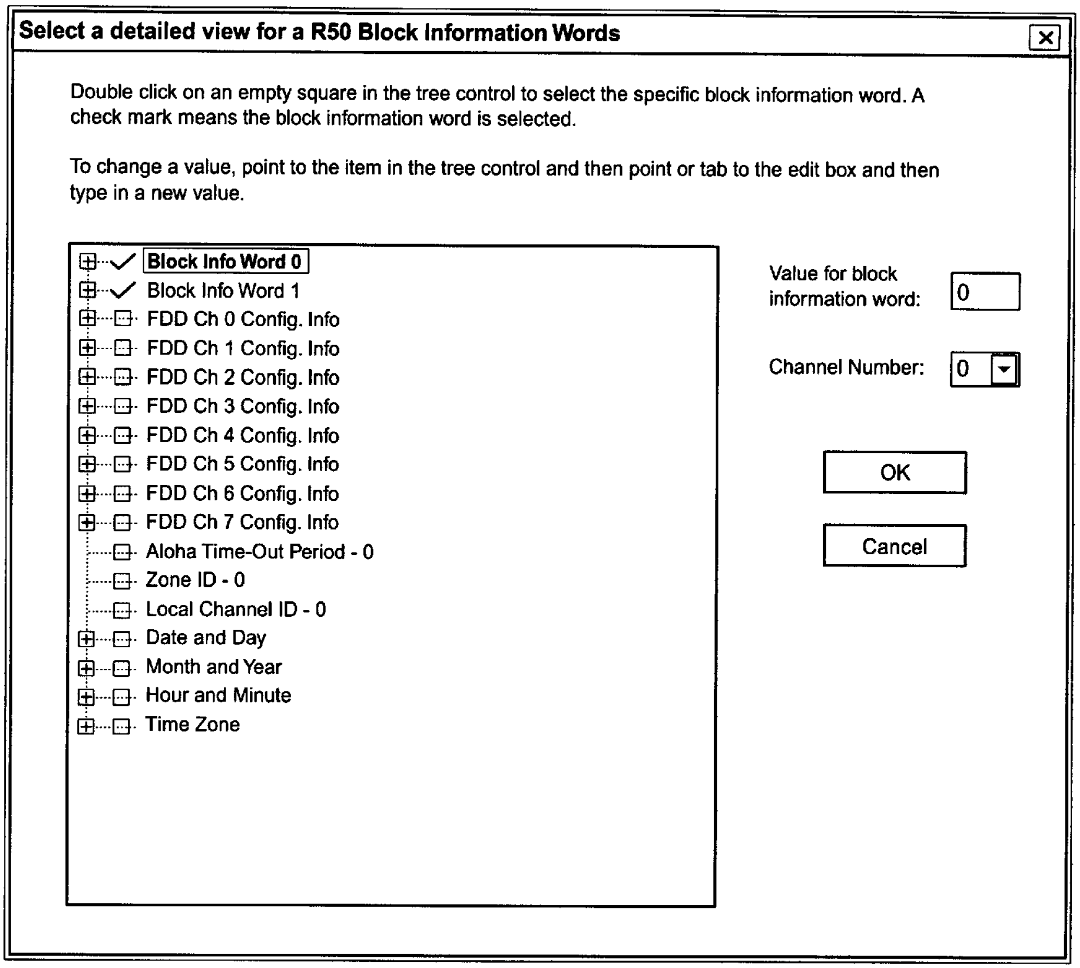

Select a detailed view for a R50 Block Information Words
Double click on an empty square in the tree control to select the specific block information word. A check mark means the block information word is selected.
To change a value, point to the item in the tree control and then point or tab to the edit box and then type in a new value.
Block Info Word 0
Block Info Word 1
FDD Ch 0 Config. Info
FDD Ch 1 Config. Info
FDD Ch 2 Config. Info
FDD Ch 3 Config. Info
FDD Ch 4 Config. Info
FDD Ch 5 Config. Info
FDD Ch 6 Config. Info
FDD Ch 7 Config. Info
Aloha Time-Out Period - 0
Zone ID - 0
Local Channel ID - 0
Date and Day
Month and Year
Hour and Minute
Time Zone
Value for block information word:
0
Channel Number:
0
OK
Cancel

FIG. 8C

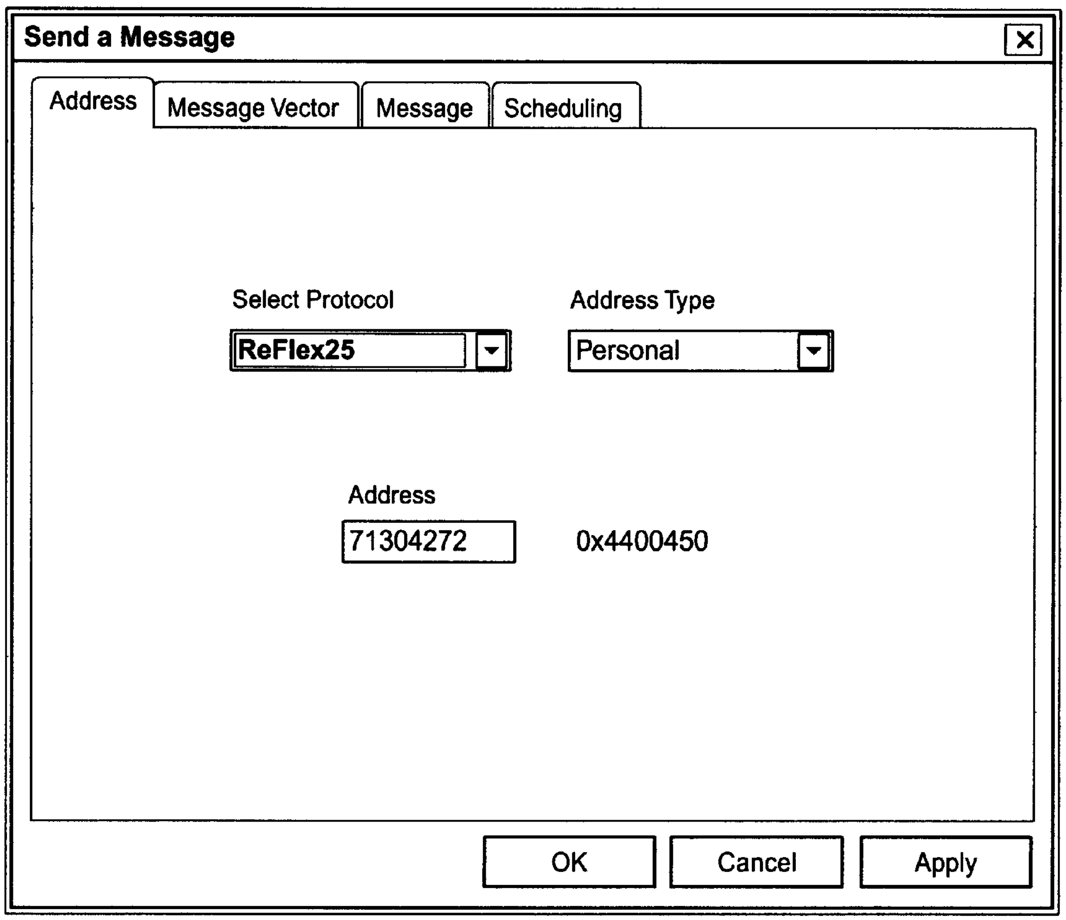

Send a Message
Address
Message Vector
Message
Scheduling
Select Protocol
ReFlex25
Address Type
Personal
Address
71304272
0x4400450
OK
Cancel
Apply

FIG. 8D

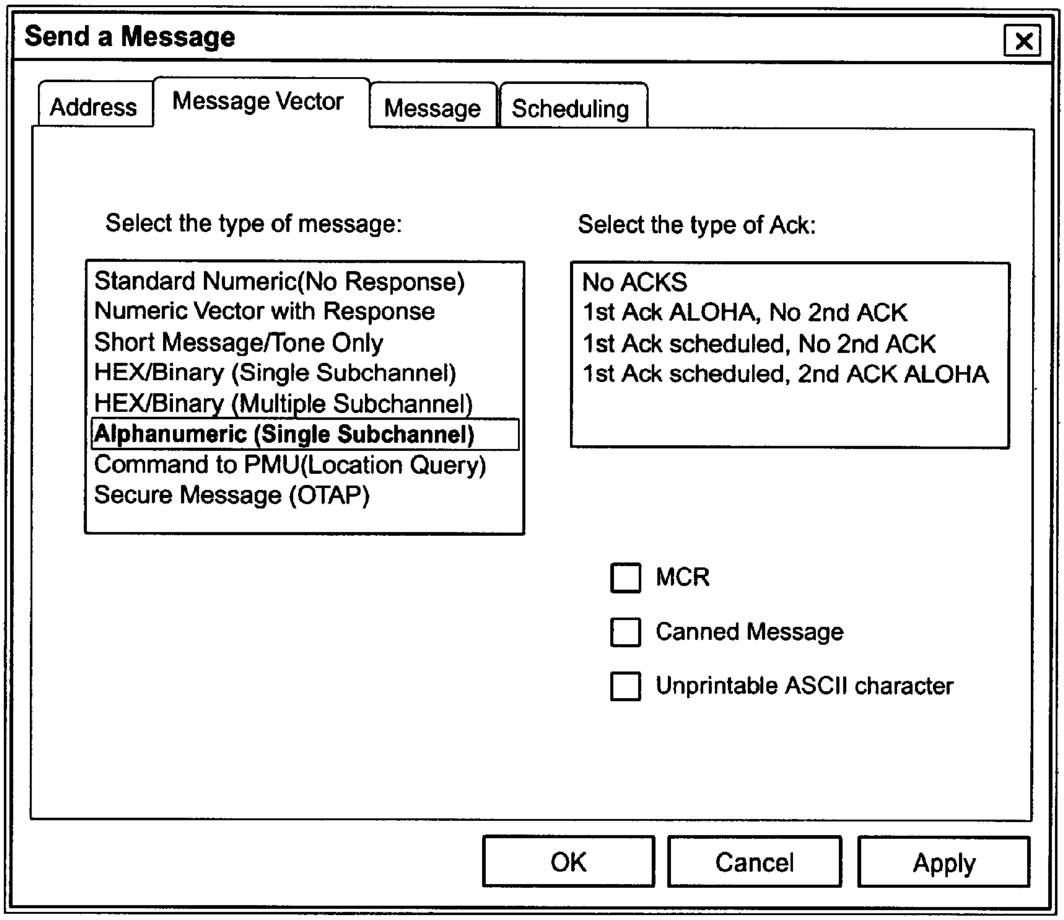

Send a Message
Address
Message Vector
Message
Scheduling
Select the type of message:
Standard Numeric(No Response)
Numeric Vector with Response
Short Message/Tone Only
HEX/Binary (Single Subchannel)
HEX/Binary (Multiple Subchannel)
Alphanumeric (Single Subchannel)
Command to PMU(Location Query)
Secure Message (OTAP)
Select the type of Ack:
No ACKS
1st Ack ALOHA, No 2nd ACK
1st Ack scheduled, No 2nd ACK
1st Ack scheduled, 2nd ACK ALOHA
MCR
Canned Message
Unprintable ASCII character
OK
Cancel
Apply

FIG. 8E

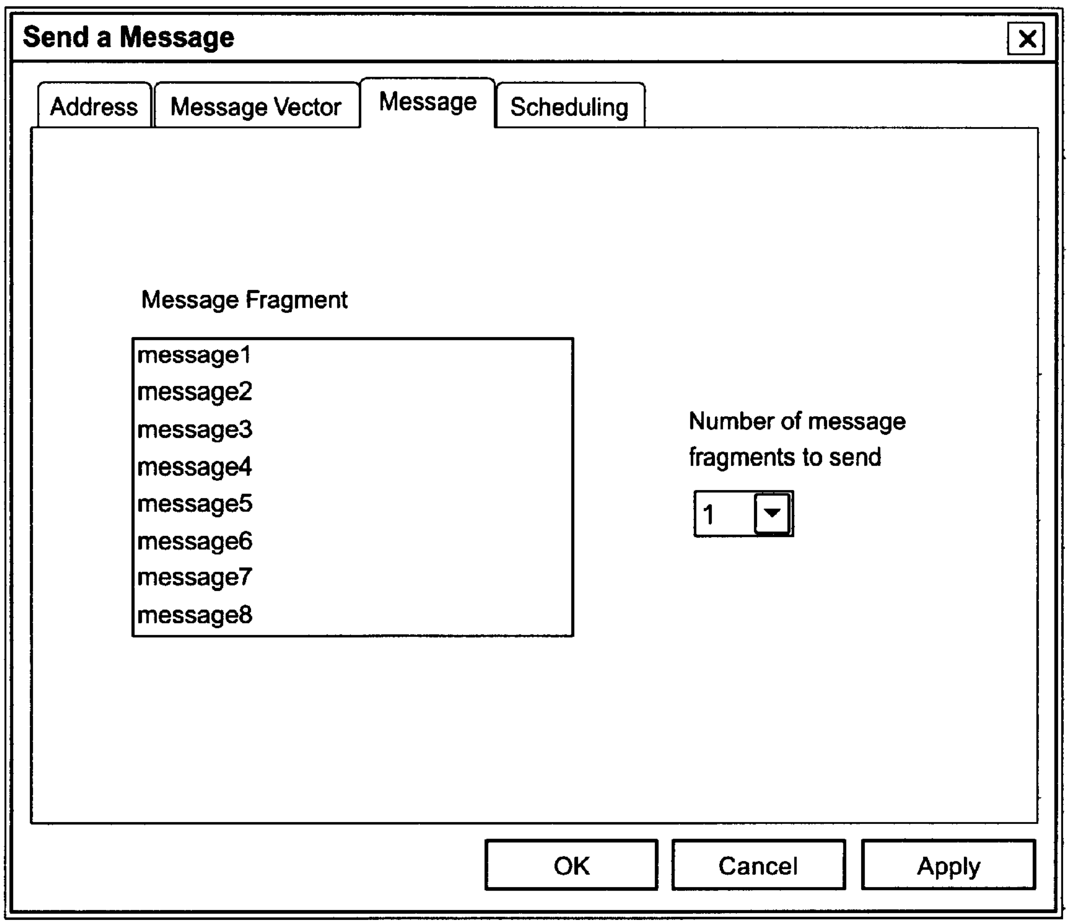

Send a Message
Address
Message Vector
Message
Scheduling
Message Fragment
message1
message2
message3
message4
message5
message6
message7
message8
Number of message fragments to send
1
OK
Cancel
Apply

FIG. 8F

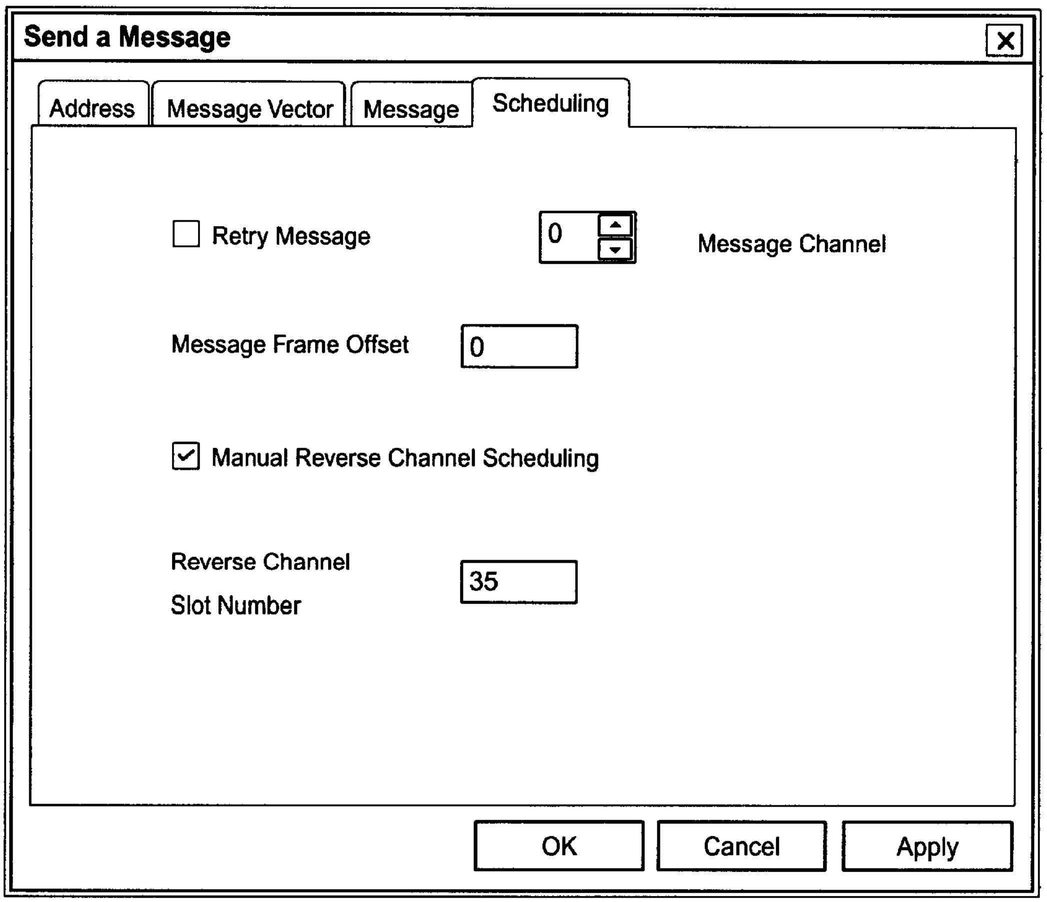

Send a Message
Address
Message Vector
Message
Scheduling
Retry Message
0
Message Channel
Message Frame Offset
0
Manual Reverse Channel Scheduling
Reverse Channel
Slot Number
35
OK
Cancel
Apply

FIG. 8G

NETWORK OPERATIONS CENTER HARDWARE AND SOFTWARE DESIGN

FIELD OF THE INVENTION

The present invention relates to the field of communications systems, such as paging systems; more particularly, the present invention relates to systems for testing communications devices, such as paging devices.

BACKGROUND OF THE INVENTION

Today, communications devices, such as paging devices undergo testing to determine whether they conform to the particular communication protocol. In the case of paging systems, there are three typically used protocols referred to as FLEX™, ReFLEX50™ and ReFLEX25™ protocols. In the prior art, protocol conformance testing is performed by one-way paging systems, and thus, only one-way devices (i.e., devices only capable of receiving paging messages, not transmitting paging messages) are tested. In the prior art, the testing is performed by a protocol encoder, which acts as a signal generator to simulate a one-way paging protocol by encoding a single outbound channel for the one-way paging device. The paging device is connected to the encoder to undergo testing. During testing, the one-way paging device could be tested for compliance to the protocol through a series of messaging scenarios.

However, newer protocols allow for two-way paging. In two-way paging, the paging network transmits and receives simultaneously, and the paging device must be tested for both receiving and transmitting. Therefore, the encoders used for testing one-way paging devices are not sufficient. Furthermore, the testing of two-way paging devices is more complicated because the protocols typically include acknowledgment or message receipt transmission, as well as message origination from the paging device. Also, the two-way paging protocols often support use of multiple channels. That is, the paging device can be made to switch communication frequencies. Each feature of the protocols for two-way paging is tested, and since paging devices receive on multiple frequencies, the tester must transmit on multiple frequencies. Therefore, a new testing system is needed to handle testing of two-way paging devices. The present invention provides such a testing system.

SUMMARY OF THE INVENTION

A system providing a multi-channel wireless communications testing environment is described. In one embodiment, the system includes a transmitter, a receiver and a protocol engine. The protocol engine is interfaced to the transmitter and receiver. The protocol engine sends information to and receives information from a two-way communication device, respectively, to test the two-way communication device for compliance with multiple communication protocols.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

FIG. **1** is a block diagram of one embodiment of a network operations center hardware architecture.

FIG. **2** is a block diagram of another embodiment of a network operations center hardware architecture.

FIG. **3** is an overview of one embodiment of a software architecture of a network operations center of the present invention.

FIG. **4** illustrates an OSI decomposition of one embodiment of a protocol engine of the present invention.

FIG. **5** illustrates one embodiment of an object decomposition of protocol-specific protocol engine objects.

FIG. **6** illustrates outbound channel message passing.

FIG. **7** illustrates inbound channel packet transmission.

FIGS. **8**A–**8**G illustrate a user interface.

DETAILED DESCRIPTION OF THE INVENTION

A system for testing communication devices is described. In the following description, numerous details are set forth, such as types of protocol, numbers of channels, coding types, etc. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring the present invention.

Some portions of the detailed descriptions which follow are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that throughout the present invention, discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

The present invention also relates to apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magneto-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, and each coupled

to a computer system bus. The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose machines may be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these machines will appear from the description below. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein.

Overview

The Network Operations Center (NOC) provides a mechanism for creating a multi-channel wireless communications environment to test paging devices (e.g., pagers). In one embodiment, the NOC system of the present invention provides a testing environment with a single platform to perform engineering testing, manufacturing testing, and application testing. The engineering testing that the NOC provides may be used to test pager software and/or hardware, such as testing, for example, an antennae or a radio frequency (RF) designs. Manufacturing testing provided by the NOC is used to test pager operation in sending and receiving messages or other information, such as for example, acknowledgments. The manufacturing testing also tests paging devices that have undergone rework or repair. Application testing allows the NOC to provide a test platform for testing application designs for one-way or two-way paging. Thus, the network operation system of the present invention provides a testing environment for paging that includes one platform that accommodates engineering testing, manufacturing testing and application testing.

In one embodiment, the system includes a transmitter, a receiver, and a protocol engine. The protocol engine is interfaced to the transmitter and receiver and may send information to and receive information from a two-way communication device, to test the two-way communication device for compliance with multiple communication protocols. A user interface provides access to and control of the NOC and its protocol engine to facilitate the testing in the three main areas of engineering testing, manufacturing, and application testing.

In one embodiment, the protocol engine comprises software being executed on hardware, allowing the NOC to support multiple protocols concurrently. These protocols can be used on multiple channels at the same time or can be combined on a single channel. In one embodiment, these protocols include FLEX™, REFLEX25™ and REFLEX50™. In one embodiment, the protocol engine controls multiple (e.g., 4, 6, etc.) forward channels simultaneously. In the case of REFLEX™, this allows it to transmit multiple channels of the REFLEX™ family. The ability to support multiple protocols concurrently, as well as multiple channels simultaneously allows for testing with adjacent channels that are of different protocols.

The present invention also provides an automated test suite environment that provides for two-way regression testing and allows for setting up and running of test scripts to two-way paging devices through the NOC.

Although the following description discusses applications of a network operations center for testing paging devices, features of the system may have applications beyond paging device testing and may be applicable to other communications devices and other systems such as data application testing over GSM, CDMA, or TDMA channels (PCS service testing).

I. Hardware Architecture

In one embodiment, the multi-channel wireless communications environment supports the transmission and reception of the FLEX™, ReFLEX50™, and ReFLEX™25 protocols to facilitate testing of paging devices.

A. A Network Operations Center Hardware Design

One embodiment of the NOC is shown in FIG. **1**. Referring to FIG. **1**, NOC **100** comprises a computer system with a processor **101** contained in a rack mount chassis. In one embodiment, processor **101** is responsible for handling coordination of all testing performed by NOC **100**. This coordination includes message generation and the processing of received messages. In one embodiment, processor **101** comprises a 100 MHz Intel 486 processor.

NOC **100** also includes a General Purpose Instrument Bus (GPIB) card **102** that is coupled to processor **101** and to a bus slot in the computer system. GPIB card **102** is a standard protocol card for test instruments. In one embodiment, the bus slot is an ISA bus slot, although other buses may be used. Through GPIB card **102**, NOC **100** is able to control multiple generators **103** via external GPIB bus **104**, setting frequency, power level, modulation, and the like. Control of signal generation using a GPIB card is well-known in the art. In one embodiment, GPIB card **102** controls 4 signal generators. Signal generators **103** modulate a data stream over the air via pre-modulation filters **120**.

In one embodiment, an optional serial port bus **105** is provided to allow another computer system **106** to communicate with and control NOC **100**. Computer system **106** may be a work station, personal computer, server-based computer system, etc. In one embodiment, computer system **106** is able to send and receive messages to wireless messaging devices by communicating with NOC **100** using a messaging protocol. Note that other systems may be coupled to NOC **100** through other parallel or serial ports included in NOC **100**.

A special Link Interface Adapter (LIA) bus **107** facilitates communication between processor **101** and the two DSP processors **108** of **109** of NOC **100**. DSP processors **108** and **109** reside on a DSP carrier board **110** in the form of 'TIM Modules'. In one embodiment, there are two such modules on the board, TIM Module A, and TIM Module B, although other embodiments may have more or less modules. DSP processors **108** and **109** handle the low level protocol activity. For example, in one embodiment, DSP processors **108** and **109** maintain strict timing for all transmitted and received channels. DSP processors **108** and **109** may also perform error correction on received data, and perform error encoding on transmitted data. There is an on-board Communications Port (COM port) **111** for communication between the modules. A DSPLINK bus **112** provides communication access between TIM Module A and a Multichannel I/O board **113**.

I/O board **113** has capability for accommodating one or more output Digital-to-Analog Converter (DAC) channels **114**, as well as one or more Analog-to-Digital Converter (A/D) channels **115**. In one embodiment, these channels operate continuously in parallel. In one embodiment, DAC channels **114** comprise 7 channels; however, any number of such DAC channels may be included in the system. In one embodiment, A/D channels **115** comprises a single 14-bit channel; however, the size and number of channels is selected to provide the requisite bandwidth.

The Interface Board **116** provides a connector mapping between the connector on the rear of I/O board **113** and the connectors required to interface to signal generators **103** and base receiver **117**.

DAC channels **118** are routed to signal generators **103** and control their FM Modulation deviation. In one embodiment, signal generators **103** drive the data transmission over the air in the 900 MHz band. In one embodiment, DAC channels **118** comprise four channels that are synchronously strobed from a common 19.2 KHz clock source on I/O board **113**. ADC channel **115** is strobed from the same clock source on DAC channel **118**. However, separate clock sources may be used. ADC channel **115** and DAC channel **115** are well-known in the art. Note that in one embodiment, the clock source also provides hardware interrupts to TIM Module A DSP processor **108**. Such interrupts are used to signal TIM Module A DSP processor to read sampled data in the ADC registers.

Base receiver **117** is a radio frequency (RF) receiver that receives data over the air from the pager and converts the information to a baseband signal. Base receiver **117** is tuned to a specific frequency within its bandwidth of operation by programming its synthesizer **121** to generate the correct local oscillator (LO) frequency. In one embodiment, base receiver **117** is capable of downconverting any ReFLEX50™ inbound channel transmission in the 901–902 MHz band; however, base receiver **117** may be configured to downconvert an inbound channel transmission adhering to any protocol. The downconverted output is provided through the audio out port **118** and is routed to the input of the ADC channel **115**. ADC channel **115** may comprise one or more channels that sample the downconverted data and forward the sampled data onto processor **101** for processing.

DAC channels **119** are routed from Multi-channel I/O board **113** to provide the required clock, data, and strobe lines to program synthesizer **121**. DAC channels **119** may comprise any number of channels may be used, including one multiplexed channel. In one embodiment, DAC channels **119** comprises three channels.

Power (VDD) and ground (GND) lines **120** are also provided to base receiver **117** from Multi-channel I/O board **113**.

Alternative Network Operations Center Design

FIG. **2** is a block diagram of an alternate embodiment of the NOC of the present invention. The main benefits of this design are lower cost, fewer processors, increased performance, and higher reliability components.

Referring to FIG. **2**, NOC **201** comprises processor **201**. In one embodiment, processor **201** comprises a 200 MHz Intel Pentium Pro **201**. The two DSP processors **108** and **109** have been eliminated, and their functionality absorbed into processor **201**. A multiple (e.g., **2**) channel ADC board **202** and a multiple (e.g., **6**) channel DAC output board **203** have replaced I/O board **113**, saving cost while increasing performance. In one embodiment, DAC output board **203** comprises two DAC channels **204** for diagnostic purposes. Any number of channels may be included in the system.

A clock board **205** provides clock signals to components of NOC **301**. In one embodiment, a first clock triggers both channels on the ADC board simultaneously. In one embodiment, the first clock comprises a 28.8 KHz clock. A second clock provides hardware interrupts to processor **201**, as well as a trigger source for the DAC output channels **203**. In one embodiment, the second clock comprises a 3200 HZ clock.

Base receivers **206** are RF receivers. In one embodiment, base receivers **206** does not have a synthesizer, but rather uses a fixed frequency crystal oscillator. This eliminates the control lines for synthesizer programming. It also has its own external power supply (not shown), which eliminates the need for power lines as well.

In one embodiment, the operating system of the NOC is a Windows 3.1 or NT operating system, sold by Microsoft Corporation of Redmond, Washington.

Although not shown, each system includes or has access to one or more memories. These memories may store information to run the system and may store database, such as class definition databases or automated test scripts described below. Also, although only one processor is shown, multiple processors or processing devices may be included in the NOC. Moreover, although multiple boards have been discussed above, many components may be included in a lesser number of boards or a greater number of boards.

II. Software Architecture

A. High-level Description

One embodiment of the software architecture of the NOC is described in FIG. **3**. Although each block is described in terms of a software, one, more or all of these features and functions of these blocks may be implemented in hardware, such as, for example, hardwired logic.

Referring to FIG. **3**, the software architecture comprises a set of blocks or modules, each of which may be autonomous. There is an Automated Test Suite (ATS) block **301** that creates message scenarios to be played back via the NOC hardware architecture. In one embodiment, ATS block **301** includes a file manager to coordinate accessing files, including opening, closing, saving, and deleting files which may be included in a database. ATS block **301** may provide a default scenario for testing one or more paging devices. In one embodiment, ATS block **301** allows users to create files that contain information for configuring the NOC and sending messages through the NOC. These files may be ASCII coded text files.

User interface **302** is a graphical user interface (GUI) that gives the user the capability to configure the NOC and send messages dynamically. Through user interface **302**, a user may select an ATS file and have the file sent onto protocol engine **303** (described below). For instance, user interface **302** allows entry of addresses of paging devices. User interface **302** allows the user to control protocol engine **303** by selecting a protocol that is being transmitted over the air, including the protocol speed and message types (alphanumeric, numeric, etc.). User interface **302** also provides a user the opportunity to obtain information (e.g., a “snapshot”) of what is happening in the NOC at any point in time. User interface **302** also allows a user to modify, change, replace and/or add data information such as, for example, parameters in an ATS file. In one embodiment, user interface **302** also allows a user to save a modified version of an ATS file. User interface **302** may be a Windows 3.1 or NT (4.0) GUI. An example of one particular interface is shown in FIG. **8A–8G**.

Protocol engine **303** accommodates multiple protocols, including the coordination of message transmission with at least one paging device for one or more of the multiple protocols being tested by the NOC. In response to an ATS file, protocol engine **303** performs scheduling and transmitting for the selected protocol, including formatting the data properly. Protocol engine **303** sends new messages out to each paging devices These messages may configure the paging device for such protocol specific features as indicating how often a message is sent, controlling the duty (collapse) cycles of a paging device, the date and time as message is sent, and which channel the paging devices is to listen to and at which time. In one embodiment, protocol engine **303** is a C++, object-oriented structure that accommodates the FLEX, ReFLEX™25, and ReFLEX™ 50 pro-

tocols. In another embodiment, an InFLEXion protocol may also be included or may replace one or more of the previously mentioned protocols, or other protocols may be included.

Device driver **304** is a block that interfaces to the NOC hardware, shown as DAC and A/D boards **306** and signal generator **307**. In one embodiment, device driver **304** comprises a Windows NT monolithic driver or other driver capable of performing a software-hardware interface. Device driver **304** performs calls to and returns from hardware in the NOC, which are based on the requirements of the hardware (e.g., boards) in the system. In another embodiment, device driver **304** comprises a virtual device driver.

Serial port interface block **305** is an optional interface that allows communication between the NOC and an external computer system or network. Serial port interface block **305** communicates with the remainder of NOC to facilitate this communication. Serial port interface **305** allows a user to bypass user interface **302** and control or program the NOC to set up a specific test or test environment. In one embodiment, serial interface port **305** is used to facilitate manufacturing testing.

In one embodiment, records are sent over the serial port interface **305** and comprise three portions, or fields, that include a record type field, a length of record field, and a data field. The record type may specify that the message type is a control message. Control messages include, for example, messages to control the power level of the paging device. Other message types include, but are not limited to, a message to specify a type (e.g., alphanumeric, numeric, and binary) or to communicate the collapsed value of a paging device (e.g., sleep or duty cycles of the paging device).

B. Protocol Engine

1. OSI Model for FLEX-family Protocols

The OSI protocol stack decomposition of the FLEX-family of protocols is shown in FIG. **4**. This architectural model of the protocol engine takes advantage of the object-oriented programming methodology. At the most generic level, the OSI decomposition is protocol independent. In one embodiment, the protocol engine is based on an OSI decomposition, which is capable of generating and receiving any FLEX-family protocol.

Referring to FIG. **4**, the OSI model includes forward channel session layer **406**, forward channel transport layer **404**, forward channel network layer **402**, forward channel data link layer **401**, device driver **304**, reverse channel physical layer **409**, reverse channel datalink layer **408**, reverse channel network layer **403**, reverse channel transport layer **405**, and reverse channel session layer **407**. During transmission of a message to an outbound channel of the NOC system, the message percolates from forward channel session layer **406** through to the forward channel data link layer **401** and out through device driver **304**. When messages are received from paging devices, they are received by device driver **304** and percolate through reverse channel physical layer **409** through to reverse channel session layer **407**.

Physical layer (Layer **1**) **409** in the OSI model is implemented through a combination of NOC hardware and the NOC device driver **304**. In the NOC, device driver **304** converts symbol information into the proper FM symbol deviation for each of the supported outbound channels (e.g., 6 outbound channels) simultaneously. In one embodiment, this symbol information is 4-level symbol information. Physical layer **409** is also responsible for updating new symbols on each of these channels at a predetermined rate of

symbols per second. In one embodiment, this rate is 3200 symbols per second. For the inbound channels, device driver **304** performs synchronization and timing recovery algorithms at the appropriate symbol rate.

Data link layer (Layer **2**) **408** looks the same for all protocols. In one embodiment, data link layer **408** is implemented for inbound channels in device driver **304** with Reed-Solomon decoding of the inbound data packets, checksum verification, and packet identification. Other decoding, verification and identification schemes may be used. In one embodiment, for multi-packet transmissions from a single paging device (e.g., subscriber device), device driver **304** extracts the data contained in the initial packet to determine the number of additional packets that follow for the message and must be received.

For the outbound channel, forward channel data link layer **401** performs the data formatting aspects of the protocol, such as block interleaving, synchronization pattern generation and detection, and formatting of all fields and parameters within those fields. In one embodiment, the outbound channel controls the message on a per frame basis. For example, each REFLEX cycle has 128 frames. With six outbound channels, there is a total of 768 frames. Each of these 768 frames is individually controlled. For example, the NOC may put an address in one frame and the message in another frame on the same channel or on other channels separated by a predetermined amount of time (e.g., four minutes). Forward channel data link layer **401** is able to implement such a scenario. In one embodiment, forward data link layer **401** performs such a scenario by using sets of pointers between the address and message.

In one embodiment, each message generated by the NOC is able to format itself at the data link layer **401**. That is, when a message propagates through the forward channel layers and reaches forward channel data link layer **401**, a messaging object specifies the protocol to which it is associated and generates addressing data formatted for that protocol. Data link layer **401** takes the codewords and places them in the correct position in the frame. The same occurs for vector and messaging fields.

Network layer (Layer **3**) outbound channel layer **402** handles the routing of message traffic to the appropriate frame and outbound sub channel number. In one embodiment, each frame within every cycle of an outbound channel, contained within a 1 hour sequence, is modeled as a destination node. Thus, there are 128 destination nodes per cycle for each outbound channel, and 1920 destination nodes within a 1 hour period per channel.

When a paging device listens to a particular frame of the outbound channel, it has a temporary virtual connection to the NOC. In this layer, the NOC determines in which frames those virtual connections will occur for a particular paging device, and on which sub channel. This allows the NOC to route outbound messages to a paging device appropriately, using the current values of the NOC collapse parameters, and the paging device collapse parameters. In other words, forward channel network layer **402** determines in which frame to transmit a message. This determination may be based on the duty cycle and the class definition parameters associated with the paging device. The routing and transit information is imported into the messaging objects and when the object is communicated to the data link layer **401**, the information is embedded in the object.

In one embodiment, the NOC uses a packing algorithm which reduces the transmission time required to transmit messages within each ReFLEX™**0** frame. This could reduce the average power consumption of a commercial transmitter

Case 2:05-cv-00443-TJW Document 190-16 Filed 06/28/2007 Page 22 of 29

by reducing the percentage of time it must be keyed at its rated output power (i.e., the amount of time the transmitter is on). In addition, optimal packing of each frame allows more messages to be placed in each frame. Thus, another benefit of this algorithm is that it maximizes the capacity of a channel, such as a ReFLEX™ or FLEX™ channel.

The packing algorithm operates in conjunction with the dynamic message scheduling of protocol engine **303**. As new messages arrive in a given frame, the entire frame is re-packed using this algorithm. Messages typically include address, vector and message components. After each is transmitted, the transmitter may turn off. As opposed to the prior art where a static allocation of time within all frames is assigned for each of these components, the present invention assigns the time interval for each of the message components on a per frame basis. Immediately before the frame is transmitted, all message components are packed into the front end of the frame. In this manner, the transmitter may be turned off in the back end of the frame. In one embodiment, the integrity of transmitted data is ensured under all conditions.

In addition, scheduling constraint information for both the outbound and inbound channels is extracted from the paging device class definition database, and handled by forward channel network layer **402**. These constraints may include the minimum outbound channel switching time and the minimum outbound to inbound channel switching time.

For the inbound channel, reverse channel network layer **403** is responsible for associating an inbound channel transmission with an outbound channel transmission. For example, an inbound acknowledgment packet is associated with the outbound channel message in this layer. Reverse channel network layer **403** is responsible for matching the forward channel and reverse channel messages based on the timeslots for transmission exchanged between transport layers **405** and **406**. In one embodiment, each message object specifies in which frame transmission is to occur and reverse channel network layer **403** correlates the outbound message and the inbound acknowledge message. Reverse channel network layer **403** passes on this information to transport layer **405**, which performs certain functions, such as database checking, discussed in more detail below.

Transport layer (Layer **4**) outbound and inbound channel **404** and **405** handle outbound and inbound channel ARQ transmissions. When a paging device wants to originate a message, forward transport layer **404** handles obtaining the portions of the message and reassembling it into an entire message. Reverse channel transport layer **405** maintains a list of all outstanding messages that haven't been acknowledged and maintains a timer for each message. If a paging device doesn't respond within the timing window set forth by the timeout period of the timer, then reverse channel transport **405** indicates to forward channel transport layer **404** that the message is to be sent again (with the assumption that the paging device didn't receive the message). Reverse channel transport layer **405** also determines that the message was error free.

To facilitate this repeating of messages, transport layers **404** and **405** include message retry logic. When acknowledgment is received through the reverse channel and an error occurs, retry logic at the reverse channel transport layer **405** signals the forward channel transport layer **405** which is buffering the previously sent message to indicate to forward transport layer **404** that the message is to be resent. Class definition database information is used at this level to handle device constraints such as maximum paging device transmission time and maximum outbound channel message fragment size. The forward channel transport layer **404** and the reverse channel transport layer **405** exchange information in a class definition database. The database maintains information specific to the class of the device. This information may include certain limitations of the device being tested. The NOC system requires such information so that it knows how to retry a message and how to schedule transmissions to and from the paging device during a test.

Forward channel session layer (Layer **5**) **406** functionality block handles the generation of outbound channel message sessions. In other words, channel session forward layer **406** handles new messaging sessions. Each session has its own session number which is used for all communications with the paging device. For example, as a new message is to be sent, the forward channel session layer **406** assigns a session number. All retries for this message use the session number. To facilitate this, the session number is incorporated into a portion of the object. In another embodiment, session layer **406** also determines what message types are allowed for a particular paging device, the current session number sliding windows for both outbound and inbound channels, and the current set of addresses programmed into the subscriber device. Device registration is validated in this layer by matching the address of the inbound registration request with a valid subscriber device in the subscriber device database.

Reverse channel session layer **407** is responsible for determining whether the message transmitted from a paging device on the reverse channel is a valid paging device. A database is searched based on the address of the paging device. If the paging device is registered, then the message is communicated to a forward channel and that page message is sent out.

If a repeat option is set, then a message is sent through the forward channel of the protocol engine and is buffered at the forward channel session layer **406**. When acknowledgment is received back through device driver **304** through the reverse channel layers, reverse channel session layer **407** provides (signals) a repeat indication to the port channel session layer **406**, causing the previously sent message to be resent through the forward channel layers and out through device driver **304**.

2. Protocol Dependent Protocol Engine

FIG. **5** illustrates one embodiment of the events, or objects, supported in one embodiment of the NOC. The leaf nodes in FIG. **5** represent actual objects within the protocol engine, which include block information (Blocklnfo) object **501**, forward message (fwrdmsg) objects **502**, and system objects **503**. The objects have a common structure. The internal tree nodes represent classifications of these objects. BlockInfo block **501** encompasses block information field objects for each of the family protocols supported by the NOC. These BlockInfo objects are capable of generating the correct data structures for their respective protocols in this field. The objects are also capable of generating Automated Test Suite files and importing data from these files as well. In one embodiment, each of these objects may include configuration information and data specific for a protocol that is communicated to the paging to enable the paging device to how the system NOC is configured.

Forward messages **502** include messages that are not acknowledged **504** and those messages requiring acknowledgment **505**.

In one embodiment, the relevant message types supported by this engine include alphanumeric, numeric, binary, over the air programming (OTAP), etc. Capability for embedded canned message tokens and multiple choice response

options is also provided, in addition to the ability to generate and import Automated Test Suite files.

System **503** objects configure the operation of the NOC system, such as, for example, objects specifying the transmit power level, transmit frequency, or protocol types (e.g., FLEX, REFLEX). This information may be included in the class definition database, the subscriber device database, etc.

Objects may be read in from an ATS file or through user interface **302** and enter protocol engine **303** at forward channel session layer **406** and continue through the forward channel layers, with each layer extracting parameters to perform its functionality.

3. Device Driver

Device driver **304** is a full-duplex signal processing module. In one embodiment, device driver **304** is capable of transmitting FLEX™, ReFLEX25™, or ReFLEX50™ frames on up to 4 outbound channels simultaneously. These frames are not static bit patterns, but contain dynamic information that is generated by the NOC application in real-time. While doing this, device driver **304** is also capable of detecting incoming data packets on up to 2 inbound channels simultaneously. The baud rate of each inbound channel is also adjustable on a per-frame basis. Signal generators **103** for each outbound channel are also individually configured and controlled by device driver **304** over GPIB bus **104**. Each frame, the output amplitude of each signal generator is adjusted, to simulate the portion of the frame in which they are "keyed on" and the portion when they are "keyed off".

Double-buffering is performed by device driver **304** on outbound frames from the NOC application program, which allows device driver **304** to transmit data while receiving data.

As is shown in FIG. **6**, the REFLEX frame is shown with a synch pattern **601** and eleven blocks of data. The frame indicates when communication occurs between device driver **304** and protocol engine **303**. Device driver **304** requests a new frame of data from the NOC application (WM_VXDNEWFRAME) prior to the conclusion of the current frame, and the NOC application responds to this request prior to the start of the next frame. In one embodiment, the request occurs after 9 of the 11 blocks in the frame. In response, the NOC application responds with a new frame. An acknowledgment from the device driver **304** (WM_VXDFRAMEACK) is provided as confirmation that the data transfer was successful. This allows device driver **304** to continuously transmit frame data, without any required guard time for receiving the next frame of data. Similarly, for new messages from a paging device, device driver **304** signals the NOC application indicating that it has a registration request. The NOC, in response to this signaling, reads the data out of device driver **304**.

Device driver **304** itself has no knowledge of the structure of the protocol e.g., (ReFLEX™) itself. Device driver **304** takes the data stream that comprises one block of data and modulates the symbols onto the forward channel.

In one embodiment, the only requirement for device driver **304** is, for each frame, to transmit a buffer of 6000 symbols at 3200 baud on each outbound channel, with 2-bits per symbol. This is consistent with the 6400 bps signaling rate. For slower rates, the NOC application is responsible for formatting the data within the 6000 symbols to produce the slower modulation. The FSK deviations for the symbols are either the ReFLEX™ deviations: ±800, ±2400 Hz, or the FLEX™ deviations: ±1600, ±4800 Hz. This can be selected on a per-frame basis for each channel. As a result, device driver **304** enables the NOC application to switch between

protocols, and/or between outbound channel speeds on a per-frame basis on each of the 4 outbound channels.

Inbound channel synchronization and symbol detection is performed at one of 4 possible inbound channel speeds. In one embodiment, the available speeds are 800 baud, 1600 baud, 3200 baud, and 9600 baud. Again, the selection of the inbound channel speed is possible on a per-frame basis for each inbound channel. In one embodiment, the inbound channel is sampled by a 12-bit A/D converter at 28.8 Ksamp/s. Since inbound channel modulation is 4-level FSK, there are 2 bits per symbol. The number of samples per symbol for each rate is: 72 samples at 800 baud; 36 samples at 1600 baud, 18 samples at 3200 baud, and 6 samples at 9600 baud. This rate ensures that even at the highest baud rate, there are sufficient samples per symbol to achieve reasonable receiver sensitivity.

In one embodiment, device driver **304** has an interrupt service routine, which processes a 3200 Hz clock interrupt that is generated by the clock card. At this rate, there are 9 new samples in the A/D FIFO in A/D board **202** on each hardware interrupt. These 9 samples are appended to the end of a circular buffer. The packet synchronization algorithm scans this circular buffer looking for a sync field match on each hardware interrupt.

On receiving messages, as packets are being received, device driver **304** looks at the first slot to identify the packet type. This directly effects the scheduling of messages (e.g., acknowledgments). For every forward channel, there are a number of slots on the reverse channel that are time synchronized. In those slots, acknowledgment messages, originated from paging devices, and registration messages are transmitted. However such transmissions must occur on or more designated slots. For example, an acknowledgment packet that is received by the NOC is only one slot long.

However when a message is sent it may be several slots long. Therefore, the NOC must quickly determine after the first packet slot is received whether there are additional packets to follow.

In one embodiment, a checksum is calculated on the message to enable detection. If not performed fast enough, the NOC must be capable of capturing all of the data regardless of its size. A problem associated with the such a system is that if the NOC must assume that each reverse channel transmission is a certain number of slots, then certain slots cannot be scheduled by the NOC. Therefore, in those cases where the packet type is a one slot acknowledgment, the additional slots that were presumed to have message information are discarded, and thus they cannot be scheduled for other packets.

When a sync match is detected, the data bits for the rest of the packet are detected and stored in an array. A Reed-Solomon decoder algorithm performs error-correction on the incoming bits. A checksum algorithm follows Reed-Solomon, and a determination of whether to discard the packet is made at the end of each algorithm processing step. In one embodiment, the checksum is calculated on the fly. By performing these functions, a quick determination may be made regarding the size of the message.

If the incoming packet data passes both steps, then the packet type is determined. This is the only portion of device driver **304** that has knowledge of the protocol (ReFLEX™) data structure. From the packet type, device driver **304** determines if a multi-packet transmission has occurred. If not, then the information bits from the single-packet of data are transferred to the NOC application. If so, then the additional packets of data are captured by device driver **304**, and the Reed-Solomon decoding algorithm is executed for

each packet. The resulting string of information bits for all the packets is then transferred to the NOC application.

For example, in FIG. **7**, there are several slots within a frame that can contain a paging device transmission. Device driver **304** scans each of these slots, looking for an incoming packet. If a packet of type 'S' is detected, it then processes the remaining 'D', or data, packets. These packets do not contain synchronization pattern, and are handled differently. A packet of type "A" is an acknowledge packet. A packet of type "M" is a message packet.

C. Automated Test Suites

The Automated Test Suite (ATS) capability allows users access to control parameters within the system, such as, for example, output channel power level, and protocol type and channel speed. One attribute of the ATS capability is that one or more parameters within any field in an (FLEX™, ReFLEX™, etc.) outbound channel can (e.g., (FLEX™, ReFLEX™, etc.) be individually controlled. In one embodiment, these parameters are controllable on a per frame basis within a 1 hour sliding window. Another feature is that configuration data for multiple protocols can co-exist in a single ATS file. This allows the NOC to be configured to interleave multiple protocols on multiple channel streams.

In one embodiment, ATS files can be loaded into the NOC dynamically. Thus, while the NOC is transmitting outbound channel data, and receiving inbound channel data, the console operator can completely re-configure the NOC by simply loading a new ATS file.

Outbound message types, such as alphanumeric, numeric, binary, etc., are supported for all protocols. This allows users the ability to replay specific messaging scenarios in an automated, scripting fashion. Class definition and subscriber databases are also included in the ATS. These databases are specific to each protocol and provide specific information that the NOC needs to know in order to properly communicate with each subscriber device.

In one embodiment, the mechanism for enabling ATS file capability is an ASCII text file, containing ATS file records. ATS files can be generated and loaded by the NOC. When an ATS file is generated, the current state of protocol engine **303** is saved in the newly created ATS file. Descriptive comments may be appended to each line in the file to increase its legibility.

The ATS file structure is based on a tagged file record format. A record exists for each paging device that the NOC system will test. Each record entry in the file begins with a record type parameter, followed by a record length parameter. The information in the record may include information about which addresses are programmed into the device, the number of simultaneous messages that may be received at the same time, the signature that should be on the first message, the duty cycle (collapse values) of the paging device and/or any other information that the NOC uses to effectively test the paging device. The information in the record may also include information which determines which of the forward channel frequencies the pager will listen to. This allows unknown record types to be discarded by the NOC without corrupting the records which follow. Users can modify ATS files, or create their own, although it is preferred that a NOC-generated ATS file be used as a template. Below is an example ATS file that was created by the NOC application. Note that other types of records are possible in an ATS file. In one embodiment, there are record types for each outbound message type, protocol type and protocol speed.

Contents of an Example ATS File

```
/* This is the test113.ats file
/*------------------------------------*/
/* ReFLEX50 Class Definition Database */
1          /* Record type */
139        /* Number of lines remaining in this record */
6          /* Number of PMUs registered in the R50 Database */
0x4400450     /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x660      /* Information Service Addr 0 *
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
9          /* Home control channel logical number */
3          /* Personal Collapse Mask value */
80         /* Personal Collapse Mask Start Frame */
17         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
1          /* Semaphore count of # of simultaneous sessions to this PMU */
0x4400473     /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x30660       /* Information Service Addr 0 */
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
```

-continued

```
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
11         /* Home control channel logical number */
3          /* Personal Collapse Mask value */
115        /* Personal Collapse Mask Start Frame */
16         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
0          /* Semaphore count of # of simultaneous sessions to this PMU */
0x44005a6     /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x660      /* Information Service Addr 0 */
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
11         /* Home control channel logical number */
3          /* Personal Collapse Mask value */
38         /* Personal Collapse Mask Start Frame */
16         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
0          /* Semaphore count of # of simultaneous sessions to this PMU */
0xcc02d7d     /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x10660       /* Information Service Addr 0 */
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
11         /* Home control channel logical number */
3          /* Personal Collapse Mask value */
125        /* Personal Collapse Mask Start Frame */
16         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
0          /* Semaphore count of # of simultaneous sessions to this PMU */
0xcc02e6a     /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x20660       /* Information Service Addr 0 */
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
11         /* Home control channel logical number */
```

Case 2:07-cv-03980-JWB-CE Document 128-6 Filed 06/28/2007 Page 26 of 29

-continued

```
3          /* Personal Collapse Mask value */
106        /* Personal Collapse Mask Start Frame */
16         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
0          /* Semaphore count of # of simultaneous sessions to this PMU */
0x440044a      /* Primary Personal Addr */
0x0        /* Additional Personal Addr 1 */
0x0        /* Additional Personal Addr 2 */
0x0        /* Additional Personal Addr 3 */
0x30660        /* Information Service Addr 0 */
0x0        /* Information Service Addr 1 */
0x0        /* Information Service Addr 2 */
0x0        /* Information Service Addr 3 */
0          /* Max Collapse for Primary Personal Address */
0          /* Max Collapse for Personal Address 1 */
0          /* Max Collapse for Personal Address 2 */
0          /* Max Collapse for Personal Address 3 */
0          /* Max Collapse for Info Svc Address 0 */
0          /* Max Collapse for Info Svc Address 1 */
0          /* Max Collapse for Info Svc Address 2 */
0          /* Max Collapse for Info Svc Address 3 */
11         /* Home control channel logical number */
3          /* Personal Collapse Mask value */
74         /* Personal Collapse Mask Start Frame */
16         /* Starting signature value for messages sent to this unit */
7          /* Information Service Collapse Mask value */
0          /* Information Service Collapse Mask Start Frame */
0          /* Semaphore count of # of simultaneous sessions to this PMU */
/*----------------------------------*/
/* FLEX/ReFLEX Frame Synchronization Record */
2          /* Record type */
11         /* Number of lines remaining in this record */
-1         /* Cycle Number */
0          /* Starting frame */
0          /* Repeat count for this record */
0          /* Forward channel number of the record */
6          /* ReFLEX protocol A pattern */
0          /* A pattern errors */
0          /* Abar pattern errors */
0          /* ReFLEX protocol B pattern */
0          /* B pattern errors */
0          /* Frame Information Word Error pattern */
0          /* C pattern errors */
0          /* Cbar pattern errors */
*----------------------------------*
/* ReFLEX50 Block Information Field Record */
3          /* Record type */
52         /* Number of lines remaining in this record */
-1         /* Cycle Number */
-2         /* Starting frame */
0          /* Repeat count for this record */
-1         /* Control channel of BI words */
1          /* Number of Forward Sub-channels */
1          /* Number of Control Sub-channels */
0          /* Personal Address Carry On */
0          /* Personal Address Collapse Mask */
0          /* Information Service Address Carry On */
0          /* Information Service Collapse Mask */
0          /* Global registration bit */
0x400f         /* BI word formats selected by this record */
0          /* Format Type */
45         /* Aloha/Scheduled slot boundary */
0          /* Reverse channel speed */
1          /* Aloha enabled */
1          /* Format Type */
45         /* Aloha/Scheduled slot boundary */
0          /* Reverse channel speed */
0          /* Aloha enabled */
2          /* Format Type */
45         /* Aloha/Scheduled slot boundary */
0          /* Reverse channel speed */
1          /* Aloha enabled */
3          /* Format Type */
45         /* Aloha/Scheduled slot boundary */
0          /* Reverse channel speed */
1          /* Aloha enabled */
4          /* Format Type */
45         /* Aloha/Scheduled slot boundary */
```

Case 1:05-cv-00393-WMS-JJM Document 190-16 128-6 Filed 06/28/2010 07/200 Page 27 of 29

-continued

```
1         /* Reverse channel speed */
1         /* Aloha enabled */
5         /* Format Type */
45        /* Aloha/Scheduled slot boundary */
0         /* Reverse channel speed */
1         /* Aloha enabled */
6         /* Format Type */
45        /* Aloha/Scheduled slot boundary */
0         /* Reverse channel speed */
1         /* Aloha enabled */
7         /* Format Type */
45        /* Aloha/Scheduled slot boundary */
0         /* Reverse channel speed */
7         /* Reverse channel start */
1         /* Aloha timeout period */
1         /* Aloha enabled */
8         /* Format Type */
1         /* Aloha timeout period */
14        /* Format Type */
0         /* Zone ID */
15        /* Format Type */
1         /* Local Channel ID */
/*-----------------------------------*/
/* ReFLEX50 Single-Channel Alphanumeric Record */
4         /* Record type */
25        /* Number of lines remaining in this record */
0         /* Cycle Number */
2         /* Starting frame */
5999      /* Repeat count for this record */
0         /* Message Retry Count */
0         /* Address type */
0x4400450      /* PMU Address */
0x0       /* Bit field allowing the protocol engine to change the record contents
*/
0         /* Subchannel of message */
0         /* Message offset from address */
17        /* Length of msg */
A Default message
0         /* Message fragment number */
0         /* Message continuation */
0         /* Message encryption */
0         /* Message compression */
0         /* Type of ack response */
0         /* Reverse channel num (for ACK) *
0         /* Number of frames before ack is transmitted */
10        /* Slot number of ack packet */
0         /* Position pointer in ack flag field */
0         /* Mail drop flag */
0         /* Multiple choice response flag */
0         /* Canned message flag */
/*----------------------------------*/
```

D. Serial Port Interface

The serial port interface provides a mechanism for transmitting messages to paging devices using an external computer system. Data is transported using variable-length record types. Data transfers from the serial port are asynchronous in nature, which allows for variable message scheduling delays in the NOC system. Each record type that is transmitted is acknowledged to ensure that the transfer was successful. In one embodiment, the message size for all outbound and inbound messages is limited to 32 Kbytes.

E. User Interface

FIGS. **8**A to **8**G illustrate an example user interface. There are two goals of the user interface for the test station. The first is to provide a clear, organized, and consistent view of the large amount of complex data. The second goal is to make NOC testing simple and easy to learn.

Referring to FIGS. **8**A and **8A-1**, data is organized visually into four groups:

Σ Summary Window **801**. Summary window **801** displays what protocol, speed, and test mode the user is testing. It also displays which channel is being used. This window gives the user information about which cycle and which frame the NOC is sending. This information may be used to read when the text is displayed in a large, boldface font. In one embodiment, when a channel is being used, the word "ENABLED" is displayed in green text and when a channel it is not, the word "DISABLED" is displayed in read text. The cycle number, frame number , total frames sent, and test mode are displayed. In one embodiment, these are displayed in reverse video because many NOC users may stand close to the display (e.g., PC monitor). NOC summary window **801** also displays the field lengths for forward channels **0–5**, indicating the address, vector and message field lengths for each block.

Σ Forward Channel Window **802**. Forward channel window **802** displays data to indicate what is occurring on the forward channel. In one embodiment, window **802** is a smaller window than summary window **801** and has a horizontal scroll bar. This allows the user to scroll backwards a predetermined number of frames (e.g., three frames, or any number of frames) to look at data. In one embodiment, window **802** has two modes: a default one with a minimum set of data fields and an advanced mode with every data field.

Case 2:05-cv-00393-WMS-TJW Document 128-6 Filed 06/28/2007 Page 28 of 29

Σ Reverse Channel Window **803**. Reverse channel window **803** displays data in the same manner as forward channel window **802**.

Σ Block Information Window **804**. Block Information Window **804** displays data in the same manner as forward channel data window **802**.

FIG. **8**B illustrates a window for selecting a test on one of the forward channels. Referring to FIG. **8**B, a list box with pre-selected frame speeds is used to select the frame speed. The pre-selected frame speed choices include an indication of the protocol for which the frame speed is possible. The forward channel is also selectable through up-down arrows which increase and decrease the channel number shown in the window. The forward channel test selection block also includes windows for specifying error patterns. In one embodiment, these windows allow for the user to enter a hexadecimal error pattern that is XORed with the requisite protocol parameter, thereby forcing errors on the transmitted data.

FIG. **8**C illustrates an example window that may be used to specify what information is to appear in the block information window **804**. As shown, multiple pre-selected choices appear in the window to specify different information that may be selected to appear at the same time in block information window **804**. The user is also able to select the value for the block information word along with the channel number. The value for block information words allows a user to assign a value to the protocol parameter selected on the left view of the window.

FIGS. **8**D through **8**G illustrate a series of windows that are used to send a message. Referring to FIG. **8**D, an address dialog box includes a list box for selecting a protocol, the address type, and a box for entering the address. There are personal and information service address types.

FIG. **8**E illustrates a dialog box for specifying a message vector. The message vector dialog box includes a list box with pre-selected choices for selecting the type of message and another list box for selecting the type of acknowledgment, including a no acknowledgment selection. The user may select a multiple device responses or canned messages, which generate unprintable ASCII characters, as part of the message body.

FIG. **8**F illustrates a dialog box for specifying the message that is to be sent. The dialog box lists pre-selected choices for a number of message fragments and a scroll box that allows the user to select a number of message fragments to be sent.

FIG. **8**G illustrates a dialog box for selecting the scheduling of the message to be sent. The scheduling dialog box indicates whether the message will be retried after the first transmission, if there is an error in sending the message or in the case where no acknowledgment is received for a message. The scheduling dialog box also includes a scroll box for selecting the message channel and indicates a message tree offset. Furthermore, the scheduling dialog box allows for selection of manual reverse channel scheduling and the entry of the specific reverse channel slot number.

The user interface is simple and easy to learn because of the use of common conventions such as the dialog boxes to open, create, and save ATS files. Dialog boxes that contain as many scrollboxes and listboxes with pre-selected choices. This eliminates some redundant typing. When the user makes a selection in a dialog box, this selection is saved by the dialog box so that the last selection is displayed when the user brings up the dialog again.

In one embodiment, a NOC may be coupled to the backbone, such as an Internet backbone, by which a Java or other application may be used to capture data and stream it into a paging device. Further, the NOC may be used individually to provide a campus paging environment or with of NOCs coupled together to provide a local paging environment.

Whereas many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that any particular embodiment shown and described by way of illustration is in no way intended to be considered limiting. Therefore, references to details of various embodiments are not intended to limit the scope of the claims which in themselves recite only those features regarded as essential to the invention.

What is claimed is:

1. A system providing a multi-channel wireless communications testing environment, said system comprising:

a transmitter;

a receiver; and

a protocol engine interfaced to the transmitter and receiver to send and receive information to and from a two-way communication device, respectively, to test the two-way communication device for compliance with a plurality of communication protocols, wherein the protocol engine transmits and receives information over multiple channels simultaneously.

2. The system defined in claim **1** wherein the protocol engine performs scheduling for a selected protocol.

3. The system defined in claim **1** wherein the communication device comprises a paging device.

4. The system defined in claim **1** wherein the protocol engine is operable to send and receive information to perform engineering testing, manufacturing testing and application testing.

5. The system defined in claim **1** wherein the plurality of protocols comprises at least a one-way communication protocol and at least a two-way communication protocol.

6. The system defined in claim **1** wherein the protocol engine uses scripted tests when testing the communications device.

7. The system defined in claim **6** further comprising an automated test script storage area to store and permit access to a scripted set of tests.

8. The system defined in claim **1** further comprising a device driver to transfer information between the protocol engine and both the receiver and the transmitter.

9. The system defined in claim **1** wherein the protocol engine comprises a series of instructions executed on at least one processor.

10. A system providing a multi-channel wireless communications testing environment, said system comprising:

transmitter and receiver hardware to transmit and receive information to and from communications devices using a plurality of channels; and

a protocol engine interfaced to the transmitter and receiver hardware via a device driver to send and receive information to and from the communication devices, respectively, to test the communication devices for compliance with a plurality of communication protocols over the plurality of channels simultaneously.

11. The system defined in claim **10** further comprising a user interface to enter information to control the protocol engine.

12. The system defined in claim **11** wherein the user interface permits a user to select one of the plurality of communication protocols for testing.

13. The system defined in claim **10** further comprising an automated test storage area storing at least one scripted test.

14. The system defined in claim **13** wherein said at least one scripted test comprises an ASCII coded text file.

15. The system defined in claim **13** wherein said at least one scripted test comprises information for configuring the system and sending messages through the system.

16. The system defined in claim **10** wherein the protocol engine comprises a retry message layer to facilitate resending of a previously sent message when an acknowledgment confirming successful transfer of the previously sent message has not been received.

17. The system defined in claim **10** wherein the protocol engine performs scheduling and transmitting for each of the plurality of protocols.

18. The system defined in claim **10** wherein the protocol engine uses an object-oriented structure.

19. The system defined in claim **10** wherein the protocol engine accesses a database to obtain device specific information to facilitate testing of a communication device.

20. The system defined in claim **19** wherein the device specific information comprises information to facilitate retrying to send a message to the communication device during a test.

21. The system defined in claim **19** wherein the device specific information comprises information to facilitate scheduling transmissions to and from the communication device during a test.

* * * * *

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF TEXAS

MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP	§	
Vs.	§	CIVIL ACTION NO. 2:05CV443
COMCAST CORP., ET AL.	§	

ORDER

The plaintiff's motion for clarification (#99) is granted.

Rembrandt sued Comcast alleging patent infringement of various United States patents. On May 12, 2006, Rembrandt served its Preliminary Infringement Contentions ("PICs") under P.R. 3-1. In its PICs, Rembrandt contended that Comcast infringes the patents-in-suit because it adheres to two industry standards: the ATSC standard for United States Patent No. 5,43,627 ("the '627 patent") and DOCSIS for United States Patent Nos. 5,852,631, 4,937,819, and 5,719,858 ("the '631, '819, and '858 patents"). Rembrandt referenced the ATSC and DOCSIS standards throughout its contentions. In addition, for several of its contentions, Rembrandt stated "[t]his claim element may include features that relate to software of the Accused Instrumentalities, and Rembrandt reserves the right to supplement or modify these contentions under Judge Ward's modification to the Local Patent Rules, Rule 3-1(h)."

Comcast did not design or manufacture the Accused Instrumentalities. It purchased equipment from third parties. This prompted Rembrandt to seek source code from third parties to aid it in developing its infringement case. As a result, Rembrandt has been receiving source code

from various third parties in a piecemeal fashion. At issue is the extent to which Rembrandt must supplement its PICs to incorporate citations to source code received from the third parties.

The question implicates the scope of P.R. 3-1(h), adopted by this court for use in cases involving claim elements satisfied by software. The rule provides:

> If a party claiming patent infringement asserts that a claim element is a software limitation, the party need not comply with P.R. 3-1 for those claim elements until 30 days after source code for each Accused Instrumentality is produced by the opposing party. Thereafter, the party claiming patent infringement shall identify, on an element-by-element basis for each asserted claim, what source code of each Accused Instrumentality allegedly satisfies the software limitations of the asserted claim elements.

This provision was intended to address a situation in which the plaintiff's ability to form infringement contentions was hindered by the unavailability of software that might reveal precisely how an accused system operated or exactly where in the accused system the claim limitation was found.

Rembrandt argues that Rule 3-1(h) does not require it to supplement its preliminary infringement contentions with specific citations to the third parties' source code. According to Rembrandt, a device compliant with the ATSC or DOCSIS standards necessarily infringes the patents-in-suit, and the defendant has admitted that its receivers and other equipment comply with the standards. Under Rembrandt's position, it would be wasteful to require it to provide specific citations to source code to prove that the accused devices comply with the relevant standards when there is no dispute that they do. Rembrandt characterizes the source code as "evidence," akin to a manual or a deposition, and argues that the rule does not require a plaintiff to provide specific citations to all of the evidence it will introduce at trial to prove its contentions. Alternatively, Rembrandt argues that any requirement to cite source code should be deferred for thirty days after

all of the source code has been produced or within fifteen days before opening expert reports are due.

Comcast argues that Rembrandt's construction of Rule 3-1(h) is too narrow. According to Comcast, the rule applies whenever a party asserts that "a claim element is a software limitation." Under Comcast's interpretation, if Rembrandt contends that an Accused Instrumentality satisfies a claim limitation because of software, then Rembrandt is required to identify the portions of the source code that meet the limitation.

The court agrees with Comcast. Rembrandt incorrectly compares source code to other types of infringement evidence. To the contrary, if a plaintiff contends that an accused product satisfies a claim limitation because it is programmed to do so, the court views the software running on the device as a part of the device. Thus, if Rembrandt intends to argue that a claim limitation is implemented in an Accused Instrumentality through software, then the burden is on Rembrandt to provide citations to the relevant portions of the source code within thirty days after the code is produced.

The court rejects Rembrandt's alternative request to defer supplementation until after all of the code is produced. To be sure, compliance with Rule 3-1(h) under the circumstances of this case will be burdensome. This is not so much a product of the rule itself, but because a number of different devices are a part of Rembrandt's case, and those products are manufactured by third parties. In the court's opinion, however, this is all the more reason to require strict compliance with the rule governing source code disclosure. Rule 3-1(h) must be read *in pari materia* with the balance of Rule 3-1, the ultimate purpose of which is to provide notice of a plaintiff's infringement contentions early on in the case. The defendant in this case is entitled to know promptly which limitations are satisfied through software and, as to those limitations, which portions of the source

code support those contentions. The court accordingly grants the motion for clarification and adopts Comcast's view of Rule 3-1(h). Leave is granted to supplement the PICs within thirty (30) days from the date of this order with the citations to the source code produced to date.

SIGNED this 17th day of January, 2007.

T. John Ward

T. JOHN WARD
UNITED STATES DISTRICT JUDGE

Case 1:07-cv-00398-GMS Document 138 Filed 06/28/2007 Page 1 of 1

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP Plaintiff, v. COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP Defendants.	Civil Action No. 2:05-cv-00443-TJW

ORDER

ON THIS DAY came on to be heard Plaintiff's Unopposed Motion for Leave to Exceed Page Limits, and the court is of the opinion that the Motion should be GRANTED.

Accordingly, IT IS ORDERED that Plaintiff's Unopposed Motion for Leave to Exceed Page Limited is GRANTED.

SIGNED this 18th day of January, 2007.

T. John Ward

T. JOHN WARD
UNITED STATES DISTRICT JUDGE

21537404.doc

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

Plaintiff,

v.

COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; AND COMCAST OF PLANO, LP

Defendants.

Civil Action No. 2:05-cv-00443-TJW

PLAINTIFF REMBRANDT TECHNOLOGIES, LP'S CLAIM CONSTRUCTION BRIEF

Frank E. Scherkenbach
Lawrence K. Kolodney
Michael H. Bunis
Thomas A. Brown
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, MA 02110
Tel: 617-542-5070
Fax: 617-542-8906

Timothy Devlin
FISH & RICHARDSON P.C.
919 N. Market Street, Suite 1100
Wilmington, DE 19899-1114
Tel: 302-652-5070
Fax: 302-652-0607

Alan D. Albright
State Bar # 00973650
FISH & RICHARDSON P.C.
One Congress Plaza, 4th Floor
111 Congress Avenue
Austin, TX 78701
Tel: 512-391-4930
Fax: 512-591-6837

Otis Carroll
State Bar No. 03895700
Wesley Hill
State Bar No. 24032294
IRELAND, CARROLL & KELLEY, P.C.
6101 S. Broadway, Suite 500
Tyler, Texas 75703
Tel: (903) 561-1600
Fax: (903) 581-1071
Email: fedserv@icklaw.com

Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

Case 2:05-cv-00443-TJW-CE Document 90-3-1 Filed 06/28/2007 Page 2 of 42

TABLE OF CONTENTS

Case 2:07-cv-00293-GMS Document 1-3 Filed 05/18/2007 Page 3 of 42

Case 1:07-cv-00398-GMS Document 1-1 Filed 06/18/2007 Page 4 of 42

TABLE OF AUTHORITIES

Page(s)

Cases

Statutes

I. FACTUAL BACKGROUND

This is a patent infringement action in which Rembrandt Technologies, L.P. ("Rembrandt") has accused Comcast Corporation and certain of its subsidiaries (collectively "Comcast") of infringing four United States Patents.

Rembrandt's business involves obtaining value for the patented inventions of technology companies and individual inventors. The patents in suit here were previously owned by Paradyne Networks, Inc., which for decades has been a leading innovator in the field of high speed digital communications systems. Paradyne engineers have been awarded hundreds of patents, many of which reflect seminal developments in the field.

Comcast is one of the nation's largest cable operators. Comcast provides cable internet services compliant with the so-called "DOCSIS" specification, which describes the operational parameters of certain telecommunications equipment including cable modems. Comcast also uses digital television equipment that complies with the so-called "ATSC" specification, which relates to the receipt and broadcast of digital television signals.

Three of the patents in suit, U.S. Patent No. 5,719,858 (the "'858 patent"), U.S. Patent No. 4,937,819 (the "'819 patent"), and U.S. Patent No. 5,852,631 (the "'631 patent"), relate to improved methods for facilitating communication between modems. These three are infringed by Comcast's cable Internet service. The fourth patent, U.S. Patent No. 5,243,627 (the "'627 patent"), covers an improved technique for error correction in a digital transmission system. It is infringed by Comcast's digital television service, specifically by Comcast's reception of certain digital television signals.

II. DISCUSSION

A. Legal Standards

Claim construction is an issue of law. *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1581-82 (Fed. Cir. 1996). Intrinsic evidence – the patent claims, specification, and prosecution history – is the primary source of guidance as to the meaning of the claim terms. "The construction that stays true to the claim language and most naturally aligns with the

patent's description will be, in the end, the correct construction." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316 (Fed. Cir. 2005) (*en banc*).

B. U.S. Patent No. 5,719,858

1. Patent Overview

Time Division Multiplexing (TDM) is a technique whereby multiple data sources may transmit data over a single network connection. The '858 patent relates to a mechanism that can allow two different types of data sources – "synchronous" data sources, which output data at a constant rate, and "packet" data sources, which output data at a "variable rate" – to agree among themselves how to allocate time slots on a single TDM bus. (Ex. 1 at 1:8-11.)

FIG. 3

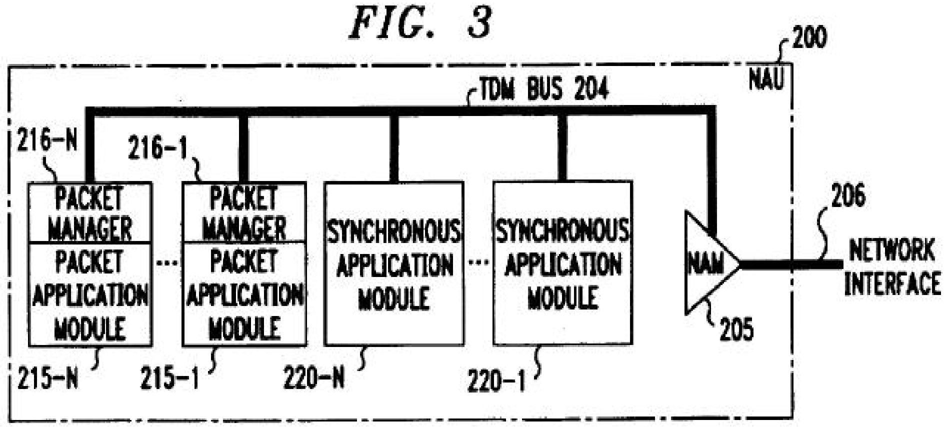
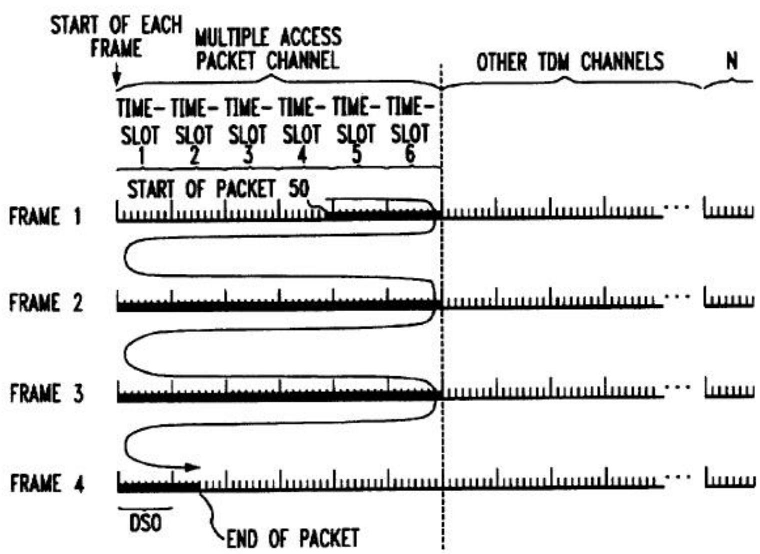


Figure 3 of the patent shows an exemplary TDM bus 204, having multiple "packet" data sources 215, and multiple "synchronous" data sources 220. In the embodiment of Figure 3, each "packet" data source 215 also includes a "distributed packet manager" 216, discussed below. The TDM bus is connected to a "network access manager" ("NAM") 205, which (among other functions) connects the TDM bus 204 to a wider network. (*Id.* at 3:46-48.)

As best shown in Figure 5, the bandwidth of the TDM bus is partitioned into regular time slots, which help to delineate "channels" on the TDM bus. For each segment of time – called a "frame" – certain timeslots are reserved for the transmission of "packet" data. These timeslots form a "multiple access packet channel," which acts as a single, common channel shared by the

packet sources. (*Id.* at 4:56-5:12.) The remaining timeslots form channels that are reserved for transmission of "synchronous" data. (*Id.* at 5:10-12.) Figure 5 shows, schematically, this division of the bandwidth. Time slots on the left-hand side are assigned to the multiple access packet channel, while time slots on the right-hand side are assigned to synchronous data channels:

FIG. 5



One aspect of the '858 patent relates to the mechanism for sharing the multiple access packet channel among the packet data sources. In certain embodiments of the '858 patent, this function is decentralized in the form of a "distributed packet manager" within each packet data source. (*Id.* at 6:6-14.)

The '858 patent includes a variety of independent claims that recite different facets of the invention. Most claims recite a TDM bus with one or more packet data sources or synchronous data sources, along with other features of the invention. Claim 1, for example, is directed to the use of a "distributed packet manager" to allocate the bandwidth among packet data sources. Claim 9, by contrast, does not recite a distributed packet manager, but instead requires that the bandwidth reserved for packet data is "shared in such a way that only one of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time." (*Id.* at

12:52-54.) Similarly, claim 11 omits the "distributed packet manager" limitation, but recites circuitry between the packet data sources and the TDM bus, including a "counter for counting time-slots representing the second portion of the predefined bandwidth." (*Id.* at 13:5-10.)

2. time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)

Construction: a bus having a bandwidth partitioned into regular time slots, that is shared by two or more sources of data by limiting each source's transmission opportunities to discrete intervals of time

Rembrandt and Comcast agree that a TDM bus is one in which different sources of data share bandwidth. Comcast, however, asserts that use of the bus is granted in a "defined, repeated sequence." This narrowing of the definition is clearly wrong. It is contrary to the teaching of the patent specification, and would exclude the preferred embodiment. *See Vitronics*, 90 F.3d at 1583 (a claim construction that excludes a preferred embodiment "is rarely, if ever, correct and would require highly persuasive evidentiary support").

The '858 patent expressly ***contrasts*** the invention with systems in which packet data sources access the bus in a regular, repeated sequence. "[The invention] is in contrast to allocating a fixed fraction of the TDM bandwidth to each packet application module." (Ex. 1 at 4:61-62.) Figure 6, for example, shows a sequence in which Module 2 sends data, and then Module 6 sends data, skipping over the intervening packet data sources. (*Id.* at Fig. 6 & 7:25-9:15.) The only reason that Module 6 sends data after Module 2, in this instance, is that Modules 3 to 5 have no data to send. In another instance, Modules 3, 4 or 5 could have followed Module 2. Indeed, even Comcast's expert testified that in the '858 patent there is no repeated sequence by which packet data sources access the bus. (Ex. 7 at 51:11-52:2.) Comcast's construction is clearly incorrect, and should be rejected.

By contrast, Rembrandt's construction is consistent with the patent specification. Figure 5 shows TDM frames according to the invention. (Ex. 1 at 3:25-27.) Comcast's expert agreed

that the frames include "individual time slots fix[ed] in size" for both the synchronous and packet data sources. (Ex. 7 at 48:9-49:17.)[1] Rembrandt's construction should be adopted.

3. packet data (claims 1, 7, 9, 11, 15 and 20)

Construction: variable bit rate data

The '858 patent claims recite a plurality of "packet data sources," and the parties dispute the meaning of "packet data." The meaning of this limitation should not be in dispute, however, because the '858 patent specification includes an express definition of "packet data:"

> The present invention relates to data communications, and more particularly to communications systems that have channelized network access, and may transport both synchronous data and ***variable-bit-rate data*** such as frame relay data (***hereafter referred to as packet data***), in a time-division multiplexed format.

(Ex. 1 at 1:8-11.)[2]

This express definition of "packet data" as "variable bit rate data" should be adopted. The definition is consistent with other disclosure from the specification. For example, in describing synchronous and packet data, the specification refers to the "asynchronous nature of packet data." (*Id.* at 1:24.) Figure 5 also shows packet data that spans an irregular number of time slots (the thick black line spanning a number of frames on the left side of Figure 5).

It is axiomatic that where a patent provides an express definition of a claim term, that definition should be adopted. *See Jack Guttman, Inc. v. Kopykake Enters., Inc.*, 302 F.3d 1352, 1360-61 (Fed. Cir. 2002) (construing a claim term consistent with the express definition provided in the specification); *see also Vitronics*, 90 F.3d at 1582 ("The specification acts as a dictionary when it expressly defines terms used in the claims or when it defines terms by implication.") Here there is no basis to stray from this definition. The term "packet data" was never an issue in prosecution, and there is no intrinsic evidence that contradicts this meaning.

---

[1] Citations to testimony of Comcast's experts, Dr. Curtis Siller and Dr. Harry Bims, as well as the pages attached as Exhibits 7 and 8 are from the draft transcripts of each deposition.
[2] Unless otherwise indicated, emphasis in this Brief has been added.

4. synchronous data (claims 7, 9 and 11)

Construction: constant bit rate data

Synchronous data is contrasted with packet data in the ’858 patent, and so should have a distinct meaning. The ’858 patent states that it relates to systems having “two types of data: synchronous data and packet data.” (*Id*. at 1:20.) Whereas “packet data” refers to data with a variable bit rate, “synchronous data” should be construed to mean “constant bit rate data.” As set forth above, the patent itself sets out an express definition for packet data as “variable bit rate data.” This same intrinsic evidence supports a definition of synchronous data as “constant bit rate data.” Newton’s Telecom Dictionary defines synchronous as data transmissions with “a constant time between successive bits, characters or events.” (Ex. 24.) According to the patent, synchronous data supports “the ability to make telephone, i.e., voice calls.” (Ex. 1 at 1:20-22.) Voice calls require constant bit rate access to the bus to minimize gaps in the signal that might degrade the quality of the call. (*See* Ex. 24, defining CBR or constant bit rate as “processes such as voice that require a constant, repetitive or uniform transfer of information.”)

Comcast concedes that synchronous data is constant bit rate data – sent between a transmitter and receiver operating “continuously at the same rate” – but seeks to add the further restriction that synchronous data “is not included in a packet.” (*See* First Amended Joint Claim Construction and Prehearing Statement (“Joint Claim Construction Statement”) (Docket No. 112)[3] at A-33.) This unsupported narrowing of the ordinary meaning of “synchronous” would read out a preferred embodiment. The ’858 patent expressly ties synchronous data to telephone calls (*id.* at 1:20-22), and describes use of the invention with certain networks called ATM networks (*id.* at 11:18-36). Comcast’s expert Dr. Siller admitted that telephone calls over ATM networks would include voice data within packets called “cells.” (Ex. 7 at 59:12-61:15.) Comcast’s construction would read out this embodiment.

---

[3] The parties intend to file a Second Amended Joint Claim Construction and Prehearing Statement with Rembrandt’s reply brief.

Comcast's proposed construction is even contradicted by its own extrinsic evidence. The IEEE definition on which Comcast relies states that "synchronous" entails "sending and receiving terminal equipment . . . operating continuously at the same rate." (Ex. 9.) It says nothing about whether or not packets may be used. Here both the intrinsic and extrinsic evidence support Rembrandt's construction, and it should be adopted. *Phillips,* 415 F.3d at 1316-17 (explaining that a claim term should be given its ordinary meaning unless the patentee clearly intended otherwise).

5. portion of the [pre-defined] bandwidth (claims 1, 7, 9, 11, 15, 20)

Construction: one or more time slots in a TDM frame assigned to a group of data sources

Both parties construe this element to relate to a portion of the bandwidth or frame that is assigned to a group of data sources (*e.g.,* packet data sources or synchronous data sources). The essence of the dispute here is whether a "portion" of the bandwidth must be less than the full bandwidth. Rembrandt's construction is consistent with the '858 patent, which never limits a "portion" to less than the full bandwidth. Indeed, the patent encompasses situations where both synchronous and packet sources are present on a TDM bus (and so neither would have the full bandwidth), and situations in which only packet sources are on a TDM bus (and so can take up the full bandwidth). The term "portion" encompasses both these embodiments,

The claims themselves evidence this breadth of scope. Claim 1, for example, recites only one type of data source, a packet data source, and allocates a "portion of the bandwidth" to packet data. In at least this claim (and its dependent claims), there are no other data sources, and so nothing to limit a "portion" to less than the full bandwidth. Comcast's construction is inconsistent with this plain reading of claim 1.

6. predefined bandwidth (claims 7, 9, 11)

Construction: a TDM frame with a fixed number of time slots

Because it relates to a TDM system, the '858 patent expressly ties bandwidth to a number of time slots. The Abstract, for example, states that a "portion of the bandwidth, or time-slots, of

the TDM bus is allocated . . . ." (Ex. 1 at Abstract.) Figure 5 shows the bandwidth partitioned into frames formed of a fixed number of time slots. (*Id.* at Fig 5.) A pre-defined bandwidth therefore has a fixed number of time slots in a frame, again as shown in Figure 5. Rembrandt's definition is drawn directly from this intrinsic evidence.

7. distributed packet manager (claims 1, 7)

Construction: a device, process or algorithm that is located within each packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data

Rembrandt's construction of "distributed packet manager" captures its proper role in the '858 invention. It is a process located within the various packet data sources (i.e., "distributed") that manages how packet sources share the time slots that are reserved for packet data.

Rembrandt's construction is consistent with the claim language itself, which simply recites that the distributed packet manager is configured to "allocate access to the allotted bandwidth among said packet data sources." (Ex. 1 at 11:46-47.) It is also consistent with the specification, which broadly states that in the '858 invention the "function of the packet manager is now distributed among the various packet application modules." (*Id.* at 3:56-58.)

By contrast, Comcast seeks a construction of "distributed packet manager" that imposes a further requirement, namely that it "prevent packet collisions." (*See* Joint Claim Construction Statement at A-34-35.) The '858 patent claims establish that Comcast's construction is wrong. Where the patentee chose to claim the concept of preventing collisions (a feature of the preferred embodiment) he did so explicitly, not using the generic "distributed packet manager" language.

Specifically, both claims 7 and 9 recite a plurality of packet data sources that "share [a] second portion of the predefined bandwidth for transmitting packet data." (Ex. 1 at 12:24-29; 12:45-50.) Claim 9 further recites that this second portion is "shared in such a way that ***only one*** of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time." (*Id*. at 12:51-54.) Claim 7, as with other "distributed packet manager" claims, does not require that "only one" packet data source access the bus at a time. Instead, it more broadly

Case 1:07-cv-00398-GMS Document 19-1 Filed 10/18/2007 Page 11 of 42

recites a "distributed packet manager" that is "configured to allocate access to the second portion . . . among said packet data sources." (*Id.* at 12:30-33.) In fact, ***no*** "distributed packet manager" claim includes any requirement that "only one" packet data source access the bus at a time. The "only one" language is what the patentee chose to express the concept of preventing packet collisions, and its omission from the "distributed packet manager" claims shows that the patentee did not intend to limit the "distributed packet manager" limitation in this way.

The specification also supports this distinction. In the Summary of the Invention, the distributed nature of the packet manager – i.e., that "no central packet manager is required" – is described separately from the feature of "avoid[ing] packet collisions." (Ex. 1 at 2:66-3:1.) In the "Detailed Description" section, collision avoidance is likewise mentioned only when introducing a specific preferred embodiment. (*See id.* at 6:53-64.)

8. allocate access to the allotted bandwidth among said packet data sources [and corresponding limitations] (claims 1, 7, 15, 20)

Construction: controlling access by each of the packet data sources to the portion of bandwidth previously assigned to packet data

The dispute regarding these limitations parallels that concerning the distributed packet manager limitation. Here Comcast seeks to read in the limitation that a given packet data source has "sole permission" to transmit in a given time period, which is essentially the same concept as "preventing packet collisions" that Comcast seeks to read into the distributed packet manager claims. As with the distributed packet manager claims, ***no claim at issue here includes the express language used by the patentee to capture the notion of preventing packet collisions*** **–** that "only one" of the packet data sources accesses the bus at a given time. This express language only appears in independent claim 9, and reading that same feature into another limitation would be improper here. *See Tandon Corp. v. United States Int'l Trade Comm'n*, 831 F.2d 1017, 1023 (Fed. Cir. 1987) ("There is presumed to be a difference in meaning and scope when different words or phrases are used in separate claims.")

9. network access manager; network access module (claim 8, 26)

Construction: a device, process or algorithm for controlling the assignment of synchronous and/or packet data portions on a TDM bus, and for passing data between the bus and a network

Claims 8 and 26 recite a "network access manager" and "network access module," elements that the parties construe together. The specification discloses two functions for the network access manager. First, it interfaces with a wider network, as shown in Figure 3. Second, the network access manager "controls time-slot allocation among the synchronous modules and the packet modules." (Ex. 1 at 5:11-13.) While Comcast does not believe the term "network access module" needs to be construed, Rembrandt believes a construction consistent with the specification would help the jury understand both what a network access module is and what functions it performs.

C. U.S. Patent No. 4,937,819

1. Patent Overview

In TDM networks (as in most networks), information takes some amount of time to travel from one network node to another. Due to factors such as the varying distances between nodes, the transmission delay or "latency" between one remote unit and a central node can be different than the latency between a different remote unit and the central node. Ranging is a mechanism by which the network can determine latency for each remote unit.

The '819 patent discloses an improved ranging mechanism for nodes on a TDM network that has multiple applications running over the network. According to the specification, the patented system compensates for transmission delays by "ranging or measuring the round-trip transmission or delay time between the master unit and each remote unit." (Ex. 2 at 2:10-12.) This range is "transmitted from the master unit to the remote units," and the remote units adjust the timing of their transmissions so that data is received at the master unit as if it were sent without delay. (*Id*. at 5:40-42.) One of the advantages of the '819 invention is to reduce empty "guard" times between transmissions, thereby making more efficient use of the network.

Claim 1 is representative. It recites a plurality of "remote units," each running one or more "application programs" and at least one unit running two or more application programs, where the remote units send data in time slots assigned to the application programs. (*Id.* at 7:29-36.) The claim further recites a master network timing means with a "period" that is subdivided into further time units. (*Id.* at 7:37-43.) That master unit also includes a "ranging means." (*Id.* at 7:44-45.) The system calculates the transmission time between the master unit and remote units, and sends that time to each respective remote unit. (*Id.* at 7:46-49.) The remote units utilize this transmission time "to adjust initiation of said time slots." (*Id.* at 7:50-51.)

2. application program[s] (claims 1, 14)

Construction: a computer program or process

The claims and specification support a broad construction of the term "application program." It is used generically both in the claims of the '819 patent, and throughout the specification and prosecution history. Neither the nature of the data that is sent between the master unit and the remote units, nor the nature of the application programs that generate that data, is important to the invention recited in the claims. This is confirmed by the inventor, who testified that the system was "transparent to the application." (Ex. 23 at 58:6-7.)

Relevant telecommunications dictionaries published around the time of the patent likewise define an application program broadly, for example "a computer program that is used for a specific application," (Ex. 10), and "a software program that carries out some useful task" (Ex. 11). Rembrandt's construction is thus consistent with both the intrinsic record and the ordinary meaning expressed in relevant technical dictionaries published at the relevant time.

In contrast, Comcast improperly seeks to narrow the meaning of application program to specifically exclude programs that "perform management of or maintenance work on the system or system components." The evidence on which Comcast relies includes several dictionary definitions that were published by end-user software manufacturers, like Microsoft, rather than by telecommunications providers, and that were published well after the '819 patent issued.

These irrelevant and untimely definitions are inconsistent with the intrinsic record and should be rejected. *See Brookhill-Wilk 1, LLC. v. Intuitive Surgical, Inc.*, 334 F.3d 1294, 1299 (Fed. Cir. 2003) (disregarding dictionary definitions that were not contemporaneous with the patent filing). For example, one untimely source that Comcast relies upon even states that "[t]he definitions on Webopedia evolve and change as technologies change, so the definitions are frequently updated to reflect trends in the field." (Ex. 12.) Another source, from a web site known as Wikipedia, is created and edited by members of the public at large rather than persons of ordinary skill in the telecommunications arts. (*See* Ex. 13.) This "evidence" comes from sources that are too general to bear on the question at hand, is not relevant to the context of these patents, and should be rejected on that basis.

3. time slot assigned to each of said application programs (claim 1)

Construction: a "time slot" is an interval of time during which data from an application program is transmitted; rest of limitation is ordinary meaning

Rembrandt's construction of "time slot" is clear from the claim language itself, which recites that each remote unit "respond[s] in a time slot assigned to each of said application programs." (Ex. 2 at 7:35-36.) The specification likewise states that remote units "respond in a unique time period assigned to each host application." The remainder of this limitation is clear on its face, and needs no construction.

Comcast's proposed construction improperly seeks to read in limitations from the specification and narrow this limitation beyond its plain and ordinary meaning. Specifically, Comcast would construe "time slot" to mean an interval of time "assigned at initialization" to each application program. Nothing in the '819 patent supports this reading, and in fact this clear narrowing would be ***inconsistent*** with the patent specification and claims.

The patent states that a remote unit can request additional time slots during data transmission (which is necessarily after initialization), and a central unit can grant the request dynamically. (*Id.* at 2:18-26; 3:7-11.) Claim 2 of the patent recites a "reservation request

generator" and "reservation request processor" that allow these additional time slots to be requested and assigned. Indeed, Comcast's expert agreed that the '858 patent describes assigning time slots dynamically. (Ex. 7 at 186:23-187:4.) Comcast's proposed construction would completely exclude these claimed features, and should therefore be rejected.

4. master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said application programs in said one of said remote units is assigned to transmit (claim 1)

Construction: "master network timing means" is a clock for determining network timing or for delineating time into time slots; rest of limitation is construed according to ordinary meaning

Rembrandt's construction of "master network timing means" is directly supported by the specification. The claim itself states that the master network timing means has a period divided into subframes, and this is precisely the description given to a specific "master network clock" in the specification: "The period of the master network clock transmission establishes a 'frame'. This frame is further segmented into subframes at the remote." (Ex. 2 at 6:37-39.) These subframes are in turn divided into time slots. (*Id.* at 7:38-39.) Thus the master network timing means is simply a clock that delineates time slots on the network.

Comcast incorrectly asserts that this limitation should be construed as a "means-plus-function" limitation under to 35 U.S.C. § 112, ¶ 6. The claim itself, however, establishes that it should ***not*** be subject to this type of construction, because it does not recite any function that is performed by the master network timing means. This failure to recite a function excludes the limitation from § 112, ¶ 6. *Rodime PLC v. Seagate Tech., Inc.*, 174 F.3d 1294, 1302 (Fed. Cir. 1999) ("a claim element that uses the word 'means' but recites no function corresponding to the means does not invoke § 112, ¶ 6"); *York Products v. Central Tractor Farm & Family Ctr.*, 99 F.3d 1568, 1574 (Fed. Cir. 1996) ("Without an identified function, the term 'means' in this claim cannot invoke 35 U.S.C. § 112, ¶ 6.")

Comcast contends that the function performed by the master network timing means is "dividing the period into subframes, and the subframes further into time slots, and assigning a time slot to each application." This misreads the claim, which does not recite that the master network timing means performs any of these functions. Rather, the claim recites that the master network timing means *has* a period that has been divided into subframes and timeslots. Comcast's expert conceded that nothing in the '819 patent suggests that the master network timing means performs this division. (Ex. 7 at 143:4-8.) In fact, the division is not performed by the master network timing means, but instead defined by a system *user*. (Ex. 2 at 4:54-55.)

The claim does not recite a function that is performed by the master network timing means, and § 112, ¶ 6 should not apply. Rembrandt's construction should be adopted.[4]

5. ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units (claim 1)

Construction: "ranging means" is a device or process that determines a transmission time between the master unit and a remote unit; rest of limitation is construed according to ordinary meaning

This limitation should be construed according to its plain and ordinary meaning, as set forth in the '819 patent specification. The specification expressly defines "ranging" as a "calculation of the time a signal takes to go from the master unit to any remote unit and vice versa." (Ex. 2 at 3:66-68.) Rembrandt's proposed construction follows directly from this description.

Comcast again seeks to apply 35 U.S.C. § 112, ¶ 6, but this effort is again improper. Although it uses the word "means," the limitation fails to recite any function performed by the ranging means. Instead, all functions recited in the limitation are linked to the master unit: "a transmission time . . . is calculated and transmitted ***from said master unit***". (*Id.* at 7:46-49.) The

[4] Should the court agree with Comcast that this limitation is governed by 35 U.S.C. § 112, ¶ 6, Rembrandt would construe the function to be generating a master network timing signal, and the corresponding structure to be the Network Timing Control Processor 12 shown in figures 1 and 3 and described at 2:60-3:6, 5:15-24 and 6:32-42. (*See* Declaration of Dr. V. Thomas Rhyne ("Rhyne Decl.") at ¶ 13.

'819 specification is again consistent with this reading, tying these same functions to the master unit rather than the ranging means: "The master unit periodically transmits a network clock reading . . . and performs a roundtrip delay transmission calculation ('ranging') to each remote unit. The master unit informs each remote unit of its precise round trip value." (*Id.* at 6:32-36.) Even Comcast's expert testified that part of the recited function (transmission from the master unit) could be performed by components other than the "ranging means." (Ex. 7 at 160:4-18.)

Because the limitation fails to link the "ranging means" to a function, the "ranging means" should *not* be construed pursuant to § 112, ¶ 6. *See Rodime,* 174 F.3d at 1302; *York Products*, 99 F.3d at 1574. Instead, the "ranging means" should be construed to mean a device or process that determines the transmission time between the master unit and a remote unit.[5]

6. reservation request generator (claim 2)

Construction: a device or process that adds to a message a request for additional time slots

Rembrandt's construction of this term is drawn directly from the '819 patent specification. The specification states that a remote unit may add a request for additional time onto an existing message to the master unit. (Ex. 2 at 2:18-22.) The reservation request generator is the element that makes such an additional request by setting "reservation bits" within the message. (*Id.* at 4:8-14; *also see id.* at 6:67-7:2.) While Comcast does not believe this limitation needs to be construed, Rembrandt's construction clarifies the meaning of this term consistent with the patent specification. The reservation request generator allows a remote unit to request additional time slots, by adding a request to an existing data transmission, during a time slot already granted to the remote unit.

[5] Should the court agree with Comcast that this limitation is governed by 35 U.S.C. § 112, ¶ 6, Rembrandt would construe the function to be ranging or determining the transit time between the master unit and a remote unit, and the corresponding structure to be the Network Timing Control Processor 12, Ranging and Network Initialization Generator 20, and Ranging Receiver 32 shown in figures 1 and 3 and described at 1:63-2:17, 2:57-3:6, 3:25-29, 3:42-49, 4:62-5:3, 5:24-34 and 6:32-36. (*See* Rhyne Decl. at ¶ 14.)

7. reservation request processor (claim 2)

Construction: a device or process for receiving and processing requests for additional time slots from a reservation request generator

Rembrandt's construction of this term is likewise drawn directly from the claims and specification. Claim 2 recites that the reservation request processor is "responsive to said reservation request bit." The specification is consistent with this function: "Reservation request processor 14 allows a drop or remote unit to request more than a single time slot for longer messages. Reservation request processor 14 communicates such a granted request to the network timing and control processor 12." (*Id.* at 3:7-11.) Rembrandt's proposed construction is again consistent with the claims and specification, and should be adopted here.

8. priority bit (claim 11)

Construction: one or more communication bits that are used to convey the relative importance of the communication

The plain and ordinary meaning of a priority bit is a bit of data that is used to convey the importance of a communication. For example, the relevant IEEE Dictionary defines priority to be "[t]he level of importance assigned to an item." (Ex. 14.) Similarly, Newton's Telecom Dictionary defines priority to be "[a] ranking given to a task which determines when it will be processed." (Ex. 15.)

Comcast's proposed construction is "[a] bit that defines the importance of a given remote unit relative to other remote units." This construction narrows the plain and ordinary meaning of the term "priority bit" by reading limitations from the specification into the claims. It is therefore improper. *Phillips*, 415 F.3d at 1323 (warning against reading limitations from the specification into the claims). Nothing in the claim limits the term "priority bit" to a bit that specifically defines the relative importance of remote units, as opposed to the application programs that run on the remote units. Indeed, Figure 5 of the patent shows that messages from each application contain "priority bits," and Comcast's expert testified that the priority could be assigned on an application by application basis. (Ex. 7 at 192:6-12; 195:4-17.)

9. dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one of said remote units, and assigning a slot to each of said application programs (claim 14)

Construction: ordinary meaning

This phrase needs no construction as its plain and ordinary meaning is clear. The master unit includes a clock having a temporal period that is divided into smaller amounts of time or subframes. The subframes, in turn, are further divided into time slots, and the application programs that run on the remote units are assigned to transmit data within the time slots.

Comcast improperly seeks to narrow this phrase by reading extraneous limitations from the specification into the claims. For example, Comcast seeks to construe a "subframe" as a time when only a single remote unit can transmit, and further seeks to limit the assignment of time slots to the initialization of the modem. This construction is clearly incorrect since it would read out the preferred embodiment. *See Vitronics*, 90 F.3d at 1583 (explaining that a construction that reads out a preferred embodiment "is rarely, if ever, correct and would require highly persuasive evidentiary support"). As set forth above in Section II.C.3, remote units can request additional time to transmit data. (Ex. 2 at 2:18-26.) If the request is granted, the remote unit utilizes time slots (and therefore part of a subframe) previously assigned to another remote unit at initialization. (*Id.* at 6:66-7:14.) Thus contrary to Comcast's construction, more than one remote unit can transmit data in a subframe, and time slots can be assigned after initialization. Comcast's attempt to read out this preferred embodiment should be rejected. *See Vitronics*, 90 F.3d at 1583.

10. means for calculating clock drifts of the remote units and issuing reset commands to correct the same (claim 12)

Construction: network timing control processor 12, configured with software to determine a drift time between the master clock and a remote clock, and to issue one or more commands to correct the drift time

The parties agree that this limitation should be construed pursuant to 35 U.S.C. § 112, ¶ 6. The function to be performed by the recited means is "calculating clock drifts of the remote units and issuing reset commands to correct the same."

Comcast asserts that the function has no corresponding structure, but this is incorrect. The specification expressly describes that "[n]etwork timing and control processor 12 uses firmware or software to implement clock drift reset functions." (Ex. 2 at 2:61-63.) It further states that the "master unit can recognize whether a remote clock is drifting and so inform the remote" by comparing a remote unit message's "actual time of arrival . . . with the expected time of arrival at the master unit." (*Id.* at 7:15-20.) The network timing and control processor 12, and the algorithm run on that processor, have been identified by Rembrandt's expert as performing the clock drift calculation function. (*See* Rhyne Decl. at ¶ 15.) Rembrandt's proposed construction is consistent with the structure and function set forth in the specification, and should be adopted.

D. U.S. Patent No. 5,852,631

1. Patent Overview

The '631 patent describes and claims a system to reduce the time required for two modems to establish communication with one another. In particular, the '631 patent deals with the establishment of the two lowest "layers" of communication protocols, referred to as the "physical layer" and the "link layer," in a taxonomy known as the Open Systems Interconnect ("OSI") Reference Model. The OSI model and the concept of multiple layers were first formalized in a paper by Hubert Zimmerman, published by the IEEE in 1980. (Ex. 16.) Because different modems may support different protocols, it is necessary for the two modems to "negotiate" which protocols they will use.

Prior to the invention of the '631 patent, two modems that needed to negotiate communication protocols would first negotiate the protocols needed to establish a physical layer connection, and then would negotiate to establish a link layer connection (one layer "up" from the physical layer). What the '631 patent inventors realized was that in many cases two full negotiations were not necessary. In particular, if the physical layer negotiation revealed that both modems supported a particular physical layer modulation, the link layer negotiations could be dispensed with. (Ex. 3 at 11:44-46.)

In the described embodiment of the '631 patent, a calling modem initiates a communication session by calling an answering modem. The two modems then negotiate a physical layer connection by agreeing upon a common supported protocol (or "modulation"). (*See* Ex. 3 at FIGS. 4-7.) After the physical layer protocol is negotiated and established, both modems use the knowledge of the negotiated physical layer to select the link layer parameters, rather than engaging in a further link-layer negotiation . (*See id.* at 12:55-61.)

Claim 1 of the '631 patent is exemplary. It begins with a preamble that describes it as a method for establishing a link layer connection between two modems, both of which support multiple physical layer and link layer protocols. (*Id.* at 14:25-31.) The first step of the method is to establish a physical layer connection by negotiating a physical layer modulation (i.e., protocol) from among the multiple supported modulations. (*Id.* at 14:32-37.) The second step of the method is to then establish the link layer protocol based on what physical layer protocol was agreed upon by the modems. (*Id.* at 14:38-39.)

2. physical layer (claims 1, 4, 5, 6, 9, and 10)

Construction: The lowest layer of the Open Systems Interconnect (OSI) seven layer model, concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems.

Rembrandt's construction of the term "physical layer" is drawn directly from the definition propounded in the article setting forth the OSI Reference Model, specifically referenced in the patent specification. (*See* Ex. 3 at 1:49.) This original and authoritative definition states that the physical layer "provides the mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections." (Ex. 16 at 430.) Similarly, the IEEE Dictionary published near the time of the invention defines "physical layer" as "the layer of the ISO Reference Model[6] that provides the mechanical, electrical, functional, and procedural characteristics [to] access . . . the transmission medium." (Ex. 17.)

[6] The ISO Reference Model is another name for the OSI Reference Model.

Comcast's construction seeks to limit the physical layer in a manner unsupported by the evidence. Under Comcast's proposal, the physical layer is solely concerned with the "electrical and mechanical" connection between the two modems, a construction that could be satisfied by two modems connected by a wire carrying an electrical current, regardless of whether they could send data back and forth. Comcast's construction purports to draw support from a section of the specification in which the patentee listed these functions as ***exemplary*** aspects of the physical layer. Nowhere does the patent suggest that this was intended as a complete definition of that layer. Indeed, Comcast's own expert conceded that the physical layer is not limited to "electrical and mechanical" aspects, but rather also includes "functional and procedural" characteristics, as Rembrandt contends. (Ex. 8 at 101:11-24.)

By explicitly referencing the OSI Reference Model, the '631 patent clearly signaled that it was utilizing the term "physical layer" as it was defined in that model, encompassing mechanical and electrical as well as functional and procedural characteristics of connections between two modems, so long as those connections occur at the lowest layer of communication.

3. physical layer modulation (claims 1, 4, 5, 6, 9, and 10)

Construction: A protocol that is concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems

The '631 patent is unambiguous that a "modulation" is simply a protocol, such as a communication standard. For example, the '631 patent explicitly refers to protocols such as V.34, V.32bis, V.32, and V.22bis as "modulations" in one paragraph (Ex. 3 at 6:15-17), and as "standard[s] or protocol[s]" in the very next paragraph (Ex. 3 at 6:35-36). Similarly, dependent claims 2 and 7 make clear that a "fast connect modem modulation" is a "physical layer modulation" (Ex. 3 at 14:40-41 & 14:64-64), while the specification refers to "fast connect" as a "protocol" (*e.g.,* Ex. 3 at 2:33-34). Since a modulation is simply a protocol, it follows that a "physical layer modulation" is a "protocol that is concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems."

Comcast's proposed construction seeks to insert additional limitations that have no foundation in the intrinsic record. Comcast argues that a physical layer modulation is the "process or protocol that defines how bits are translated into waveforms and transmitted at the physical layer." The '631 patent, however, does not discuss translating bits into waveforms. Indeed, the "fast connect" modulation has nothing to do with translating bits into waveforms, but rather is simply a protocol that "provide[s] for faster and more efficient startup operation." (Ex. 3 at 2:29-31.)

In support of its position, Comcast cites extrinsic evidence including one dictionary definition from 2002, well after the 1997 filing of the patent-in-suit. Comcast's evidence includes no treatises or dictionaries relating specifically to modem technologies. Most significantly, Comcast's extrinsic evidence is inconsistent with the patent's disclosure. Therefore, Comcast's construction should be rejected. *See Vitronics*, 90 F.3d at 1584 (holding that extrinsic evidence may not be used to contradict the specification).

4. negotiated physical layer modulation (claims 1, 2, 4, 5, 6, 7, 9, and 10)

Construction: A physical layer modulation selected by a process permitting two modems supporting different physical layer modulations to agree on a common supported physical layer modulation

The intrinsic record explicitly defines what is meant by the term "negotiated." During prosecution, the applicant stated that "***[b]y choosing a physical layer modulation based on the capabilities of the two modems as determined at run time,*** the two modems '***negotiate'*** an appropriate physical layer modulation scheme." (Ex. 18 at 6.) The applicant distinguished prior art cited by the examiner by noting that the cited art "teaches that each computer should have a modem with 'a fast modem connect protocol.' . . . This teaches away from the present invention which allows modems with different connection speeds to ***establish a mutually acceptable protocol.***" (Ex. 18 at 7.) Thus, according to the applicant, a "negotiated" physical layer modulation is one selected by a process that allows modems with different capabilities to arrive at a mutually acceptable protocol.

Rembrandt's proposed construction is also supported by the claims themselves. The '631 patent claims recite that the calling modem have a "plurality of possible first physical layer modulations," and that the answering modem have "a plurality of possible second physical layer modulations." (*E.g.,* Ex. 3 at 14:26-28.) The physical layer connection that is established is "based on a negotiated physical layer modulation chosen from said first and second physical layer modulations." (*E.g.,* Ex. 3 at 14:34-36.) Thus, the claims recognize that the calling and answering modems may support different physical layer modulations, and the purpose of the negotiation is to choose a modulation that the modems have in common.

Comcast, again relying on extrinsic evidence, seeks to read out of the claim any requirement for actual negotiation. In Comcast's view, there is no requirement that the negotiation allow modems supporting different protocols to agree on a common supported protocol. This feature, however, is the central concept upon which the applicant relied to distinguish the prior art during prosecution, and even Comcast's expert acknowledged that the claimed negotiation entailed "permitting two modems supporting different physical layer modulations to agree on a physical layer modulation." (Ex. 8 at 181:2-12.)

Rembrandt's construction is supported by the claims, specification and prosecution history, whereas Comcast's construction is contradicted by its own expert. Rembrandt's construction should be adopted.

5. link layer (claims 1, 3, 4, 5, 6, 8, 9, and 10)

Construction: The second lowest layer of the Open Systems Interconnect (OSI) seven layer model, providing the functional and procedural means to transfer data between modems, and to detect and correct errors that can occur in the physical layer

The IEEE Dictionary (published the same year as the patent's effective filing date) defines "link layer" as the "layer of the ISO reference model that provides the functional and procedural means to transfer data between stations [*i.e.*, modems], and to detect and correct errors that can occur in the physical layer." (Ex. 19.) Rembrandt proposes that the Court adopt this definition, substituting "modems" instead of "stations" for clarity.

The patent specification is fully consistent with this definition. The patent is explicit that the link layer is where error correction takes place. For example, dependent claims 3 and 8 explicitly state that "said link layer connection is an error-correcting protocol." (Ex. 3 at 14:42-43 & 14:66-67.) In the described embodiment of the'631 patent, a link layer protocol called V.42 "is intended for use in establishing the error correcting protocol of the data link layer connection." (Ex. 3 at 2:41-43.)

Comcast seeks to depart from this well accepted usage of "link layer" by reading in unnecessary limitations. Specifically, Comcast contends that the error correction in the link layer may only be of a particular kind, namely error correction that is achieved "through frame retransmission."

Comcast's proposed limitation is unwarranted. While correction of physical layer errors is one function that is provided by the link layer, nothing in the '631 patent requires that "frame retransmission" be the exclusive means by which it is achieved. As noted above, the patent specifically refers to the OSI seven-layer model, and nothing in that model – or in the IEEE definition – requires error correction through "frame retransmission."

Moreover, the extrinsic evidence supports Rembrandt's position that error-correction in the link layer may be accomplished through means other than frame retransmission, such as through the use of error correction codes. For example, an article presented at a conference in September, 1997, proposed a "scheme ***which uses a block FEC code in the data link layer*** for correcting bit errors of the received packets." (Ex. 20 at 205.) As Comcast's expert testified, an FEC (forward error correction) code can itself detect and correct errors occurring in the physical layer – without relying on frame retransmission. (*See* Ex. 8 at 133:16-19 and 144:6-12.)

Similarly, the work of Comcast's own expert shows that detection and correction of errors that can occur in the physical layer can be achieved in the link layer using "Reed-Solomon decoding" – a type of error correction code. (Ex. 8 at 77:5-10; 111:12-112:4; 113:12-14; 133:16-19.) This evidence belies Comcast's contention that error correction in the link layer must occur

"through frame retransmission." Comcast's attempt to import a requirement that error correction be accomplished through frame retransmission should be rejected.

6. The Structure Corresponding to the Means Plus Function Terms Should Be Limited to that Structure that Is Necessary to Perform the Recited Function

Claims 6 and 9 include means-plus-function terms. Rembrandt's designation of the structure corresponding to the recited function is limited to what is necessary to perform the corresponding function. *See Default Proof Credit Card Sys., Inc. v. Home Depot U.S.A., Inc.*, 412 F.3d 1291, 1298 (Fed. Cir. 2005). In contrast, Comcast seeks to incorporate large swaths of portions of the patent disclosure that even Comcast's expert admits are unnecessary. (*See* Ex. 8 at 227:10-19; 228:7-15; 234:20-235:10; 237:8-16; 238:23-239:2; 239:19-240:7.)

The '631 patent discloses programmable hardware such as a microprocessor (specifically, a control processor or a digital signal processor chip (*see* Ex. 3 at 6:10-11)), configured to execute algorithms corresponding to the functions recited in claims 6 and 9. (*See* Rhyne Decl. at ¶¶ 10-12.) Thus, the structure corresponding to each of the means-plus-function terms is programmable hardware configured to execute the identified algorithm. *See WMS Gaming, Inc. v. Int'l Game Tech*, 184 F.3d 1339, 1348 (Fed. Cir. 1999).

The function of the first term is "establishing a physical layer connection based on a negotiated physical layer modulation." (*See* Joint Claim Construction Statement at A-13.) The structure necessary to perform this function is programmable hardware configured to execute the algorithm set forth in those aspects of the patent's Figures 4-7 that are highlighted in the attached Exhibits 5-A through 5-D, or equivalent structures. (*See* Rhyne Decl. at ¶ 10.)

The function of the second term is "establishing the link layer connection based upon the negotiated physical layer modulation." (*See* Joint Claim Construction Statement at A-15.) The only structure necessary to perform this function is programmable hardware configured to "establish[] a link layer connection substantially instantaneously upon the completion of the physical layer negotiation," or equivalent structures. (*See* Ex. 3 at 11:44-46; Rhyne Decl. at ¶ 11.)

Finally, the function of the third term is "presetting link layer parameters based on the negotiated physical layer modulation." (*See* Joint Claim Construction Statement at A-16.) The only structure needed to perform this function is identified clearly in the specification: programmable hardware configured to "[p]reset[] the XID phase parameters to default values that are based upon the negotiated physical layer connection," and equivalent structures. (*See* Ex. 3 at 12:59-61; Rhyne Decl. at ¶ 12.)

E. U.S. Patent No. 5,243,627

1. Patent Overview

The '627 patent generally relates to the field of error correction in digital transmission systems. In such systems, a sequence of digital data is transmitted from a transmitter to a receiver, typically by modulating an analog waveform using the digital data. (*See* Ex. 4 at 4:62-64.) When the analog waveform is received at the receiver, it must be demodulated to recover the transmitted digital data. (Ex. 4 at 4:48-66.)

A basic problem in the design of such data transmission systems is how to eliminate the effect of "noise" introduced into the data signal during transmission. (Ex. 4 at 1:29-33.) This noise, which may result for example from environmental factors or imperfections in the transmission equipment, can modify the transmitted signal so that the analog signal received by the receiver is different from what was transmitted by the transmitter. Such noise can "worsen the effectiveness of the . . . receiver to recover the transmitted data." (Ex. 4 at 1:29-33.)

Digital data transmission systems typically include some type of error correction coding to aid in the recovery of the transmitted signal. (Ex. 21 at 1:23-37.) These error correction codes aim to mitigate the problems caused by noise. (Ex. 21 at 1:23-37.) In one technique, the transmitter includes a so-called "trellis encoder" to encode data while the receiver includes a corresponding trellis or "Viterbi" decoder to decode data. (Ex. 21 at 2:44-45 and 3:21-29.)

The trellis encoder adds "redundant bits . . . systematically to the data bits" to be sent before modulation. (Ex. 21 at 1:37-41.) There is an "inherent correlation between these redundant bits," which is used to help the receiver recover transmitted data that is lost because of

noise. (Ex. 21 at 1:41-43.) Because the trellis encoder allows "only predetermined transitions from one sequential group of bits . . . to another," the Viterbi decoder is able to determine from a received sequence of bits whether that sequence is erroneous – i.e., whether it fails to follow the prescribed pattern of transitions – and if so, to estimate the most likely sequence that was actually transmitted. (Ex. 21 at 1:37-41.)

While useful, Viterbi decoders can fail to properly correct errors under certain conditions. In particular, Viterbi decoders can fail to correct data streams affected by "relatively long error signals," i.e., bursts of noise that affect a sequence of transmitted data over an extended period of time. (Ex. 21 at 1:46-50.) Such error signals – referred to in the '627 patent as "correlated noise" – "inhibit[] the correction of received bits" using Viterbi decoders because too many successive received data values are erroneous. (Ex. 4 at 1:38-44; Ex. 21 at 1:46-52.) The closest valid sequence as determined by the Viterbi decoder may not be the sequence that was actually transmitted.

The '627 patent, which was issued to William Betts and Edward Zuranski, teaches a novel mechanism, called "signal point interleaving," for reducing the vulnerability of Viterbi decoders to correlated noise. As the '627 patent explains, this mechanism represents an improvement over an earlier technique called "channel symbol interleaving" that was disclosed by Mr. Betts and others in prior art U.S. Patent 4,677,625 ("the '625 patent"). (Ex. 4 at 1:33-2:2.)

The earlier channel symbol interleaving technique entailed using multiple trellis encoders in a single transmitter, and multiple corresponding Viterbi decoders in the corresponding receiver, to improve the correction of errors caused by correlated noise. (Ex. 4 at 34-38; Ex. 21 at 1:56-59.) In the preferred embodiment of the '625 patent, the transmitter comprised a "distributed trellis encoder" having four distinct trellis encoder elements, as shown in Figure 1 of the '625 patent, reproduced (with color highlighting added) in Exhibit 6A.

To accomplish channel symbol interleaving, data was sent to the individual trellis encoders in "round-robin fashion," meaning the trellis encoders take turns operating on data.

(Ex. 4 at 1:59-62.) Accordingly, only the currently "active" trellis encoder would encode data, while the "other . . . trellis encoders are idle." (Ex. 21 at 2:50-52.) The receiver in the '625 patent would use a corresponding distributed Viterbi decoder to decode the received data (Ex. 4 at 1:62-65; Ex. 21 at 2:2-4, 3:67-4:3), as can be seen in Fig. 3, reproduced with added color highlighting in Exhibit 6-B. Like the distributed trellis encoders, the distributed Viterbi decoders operated in a round-robin fashion, so that only one Viterbi decoder was active at a time. (Ex. 21 at 3:43-49.) As a result, each Viterbi decoder in the receiver only decoded that data that was generated by a corresponding trellis encoder in the transmitter. (*See* Ex. 21 at 3:47-55.)

The advantage of using multiple, corresponding pairs of round-robin activated trellis encoders and Viterbi decoders, as opposed to a single conventional trellis encoder / Viterbi decoder pair, lay in the resulting "*interleaving*" of data transmitted between the respective pairs of encoders and decoders. (Ex. 4 at 1:59-2:2.) In particular, the round-robin mechanism caused "channel symbols" from a given trellis encoder – values representing successive chunks of data processed by the trellis encoder – to be separated from each other on the transmission channel. (Ex. 4 at 1:59-2:2.) The figure in Exhibit 6-C illustrates the resulting pattern of channel symbols on the transmission channel, with each color representing channel symbols that are encoded and decoded by respective trellis encoder/decoder pairs.

As can be seen from this pattern, no two channel symbols associated with a given trellis encoder/decoder pair are adjacent to each other on the transmission channel. (*See* Ex. 4 at 1:59-2:2.) As a result, correlated noise would have to last longer to affect enough channel symbols from any given trellis encoder to prevent their accurate reception by the corresponding Viterbi decoder.. (*See* Ex. 4 at 1:49-52.) For example, consider a burst of noise that impairs the values of four consecutive channel symbols in the stream above. If all the channel symbols were to be processed by a single trellis encoder/decoder pair, the Viterbi decoder would have to correct four successive erroneous values, possibly overwhelming its ability to recover the original data stream. (*See* Ex. 21 at 1:41-52.) However, when the noise impacts channel symbols from four separate trellis encoder/Viterbi decoder pairs operating in a round-robin fashion, each Viterbi

decoder would only need to decode one of the four erroneous channel symbols, thereby reducing the likelihood that any given Viterbi decoder would fail to make the proper error correction. (*See* Ex. 4 at 3:61-64.)

The improvement of the ’627 patent comprises augmenting the channel symbol interleaving technique disclosed in the ’625 patent with an additional technique called “signal point interleaving.” (Ex. 4 at 2:12-14.) Whereas the channel symbol interleaving of the ’625 patent provides a way of reducing the amount of correlated noise seen in *successive channel symbols* transmitted between a given trellis encoder/Viterbi decoder pair, the addition of signal point interleaving takes this concept one step further by reducing the amount of correlated noise *within a single channel symbol*. (Ex. 4 at 2:5-14.)

As in the ’625 patent, the transmitter of the ’627 patent features a “distributed trellis encoder” comprising, in the preferred embodiment, three trellis encoder “stages” that operate in a round-robin fashion. (Ex. 4 at 4:64-5:5.) The preferred transmitter of the ’627 patent, illustrated in Figure 3, is reproduced (with color highlighting added) in Exhibit 6-D. Three trellis encoder stages, 319α, 319β and 319γ, perform channel symbol interleaving in a manner essentially the same as that taught in the ’625 patent (Ex. 4 at 5:1-5): successive channel symbols generated using a given trellis encoder stage are separated from one another by other channel symbols generated using the other two trellis encoder stages. As in the ’625 patent, this reduces the likelihood of correlated noise affecting successive channel symbols to be decoded by the same Viterbi decoder stage.

The ’627 patent then provides an additional technique – signal point interleaving – that reduces the amount of correlated noise within a single channel symbol. (*See* Ex. 4 at 2:5-14.) Reducing correlated noise within a single channel symbol is advantageous in coding systems where larger amounts of data are allocated to each trellis encoder every time a trellis encoder is active. (*See* Ex. 4 at 2:5-14 and 2:61-3:3.) Larger inputs fed into each active trellis encoder produce larger trellis encoded channel symbol outputs. (Ex. 4 at 3:52-4:3.) These larger channel symbol outputs often need to be sent in more than one signaling interval.

Case 2:05-cv-00443-TJW-CE Document 119-1 Filed 01/18/2007 Page 33 of 42

For example, the trellis encoded channel symbol shown in Exhibit 5-D is too large to be modulated by the transmitter in one "signaling interval" – a unit of time corresponding to how much digital data can be represented at once on an analog waveform to be transmitted to the receiver. (Ex. 4 at 2:21-28; Ex. 4 at 3:38-42.) Instead, it is composed of multiple "signal points," each of which can be modulated during a single signaling interval. (Ex. 4 at 3:38-42; & 3:52-4:3.) In the diagram shown in Exhibit 6-E, therefore, it takes two signaling intervals to modulate and transmit the trellis encoded channel symbol from the transmitter to the receiver, with one signal point being modulated and transmitted during each signaling interval. (*See* Ex. 4 at 3:38-42.)

What the inventors of the '627 patent discovered was that in data transmission systems where multiple trellis encoders encoded channel symbols comprised of multiple signal points, the signal points of any single channel symbol remained vulnerable to correlated noise because they remain adjacent to one another. (Ex. 4 at 2:5-13). To solve this problem, the inventors of the '627 patent developed a signal point interleaving technique that requires "the constituent signal points of the channel symbols to be non-adjacent as they traverse the channel." (Ex. 4 at 2:5-13.)

The effect of this further optimization on the transmission pattern of signal points can be seen in two sequences found in Exhibit 6-F, which are taken from Figure 5 of the '627 patent (with color highlighting added). Both sequences show the signal points that make up the channel symbols generated using respective trellis encoder stages 319α, 319β, and 319γ. In the first sequence, only the invention of the '625 patent is used. As a result, while the channel symbols generated by the different trellis encoders are spaced apart from each other (e.g., channel symbol [$x_0^\alpha x_1^\alpha$] is spaced apart from channel symbol [$x_6^\alpha x_7^\alpha$]), the component signal points of each channel symbol remain adjacent to each other. (*See* Ex. 4 at 6:62-7:6.) "[S]ince all the signal points of a channel symbols must be processed serially by the same Viterbi decoder stage, this means that the Viterbi decoder must process adjacent signal points that have highly correlated noise components." (Ex. 4 at 7:1-6.)

By contrast, in the second sequence, which was generated using the invention of the '627 patent, there is a separation of at least three signaling intervals between a) the signal points which belong to any particular channel symbol, and b) the signal points which belong to successive channel symbols output by a given trellis encoder. (Ex. 4 at 7:58-64.) This combination of signal point interleaving and channel symbol interleaving reduces the effect of correlated noise during transmission and improves the ability of the Viterbi decoder stages to correctly receive the transmitted signal. (Ex. 4 at 7:55-8:2.)

2. Exemplary Claim: Claim 9 of the '627 Patent

Claim 9 (Ex. 4 at 11:12-35) provides an example of the claims at issue in this case. The claim begins by asserting that it is directed to the receiver of a data transmission system that receives a stream of "trellis encoded signal points":

> *Receiver apparatus for recovering information from a received stream of trellis encoded signal points,*

The claim then shifts focus to the transmitter, describing how that stream of signal points is created in the transmitter. Consistent with the patent's teaching of multiple trellis encoders, the claim indicates that these signal points must be generated as part of two or more "streams" of trellis encoded channel symbols:

> *said signal points having been transmitted to said receiver apparatus by transmitter apparatus which generates said signal points by generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information,*

The trellis encoded channel symbols each have multiple signal points:

> *each of said channel symbols being comprised of a plurality of signal points,*

There is an interleaving process that takes place to form the stream of signal points to be transmitted:

> *and by interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points,*

As discussed above, the required interleaving involves separating the data in two ways. First, the interleaving must separate the signal points within a given channel symbol, i.e., they must be "non-adjacent":

> *said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points*

Second, the interleaving must separate the channel symbols emanating from each trellis encoder stage (or more precisely their component signal points):

> *and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,*

The focus then returns to the receiver:

> *said receiver apparatus comprising*

The receiver includes a way to reverse the interleaving process that took place in the transmitter:

> *means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and*

The receiver also includes a Viterbi decoder with multiple stages to recover the information transferred via the signal points:

> *a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.*

3. trellis encoded channel symbol (claims 9, 19)

> *Construction: a set of one or more trellis encoded signal points that corresponds to a group of bits that is treated as a unit by an encoding system*

Rembrandt's construction of the term "trellis encoded channel symbol" is fully consistent with and supported by the intrinsic record. The patent specification, the "single best guide to the meaning of a disputed term," *Phillips*, 415 F.3d at 1315, specifically describes how to identify a trellis encoded channel symbol.

> ***Serial-to-parallel converter 115 . . . provides, during each succession of symbol intervals, some predetermined number of parallel bits on lead 109*** and some number of parallel bits on lead 108 . . . [T]he words on lead 109 are used by trellis encoder 119α to sequentially identify on lead 121N [sic "121 N"] subsets, while

Case 1:07-cv-00398-GMS Document 1-31 Filed 06/18/2007 Page 37 of 42

> the words on lead 108 are used to generate N corresponding index values on lead 117. The N signal points ***identified in this way*** are the component signal points of a 2N-dimensional [trellis encoded] channel symbol.

(Ex. 4 at 2:61-65 and 3:53-58.) Thus, according to the ’627 patent, a channel symbol is the output of the trellis encoding process corresponding to a group of input bits – the “parallel bits” – that are grouped together and presented to the trellis encoding mechanism. This group of bits is used to form, and thus corresponds to, the trellis encoded channel symbol generated by the trellis encoding mechanism. Comcast’s expert agreed that a trellis encoded channel symbol is a function of these parallel bits. (Ex. 8 at 273:3-8.) Thus, Rembrandt’s construction reflects this explicit teaching of the ’627 patent.

Comcast’s construction, on the other hand, limits trellis encoded channel symbols to outputs derived from a “single state transition” of the trellis encoder. Such a limitation is not supported, and in fact is directly contradicted, by the patent specification. According to the patent, a channel symbol is derived from “a succession of N outputs from the trellis encoder.” (Ex. 4 at 4:20.) As Comcast’s expert admits, each of these multiple outputs of the trellis encoder corresponds to a separate state change. (Ex. 8 at 247:5-9.) Thus the channel symbols specifically described in the ’627 patent would not satisfy Comcast’s definition, making that definition presumptively incorrect. *Primos, Inc. v. Hunters Specialties, Inc.,* 451 F.3d 841, 848 (Fed. Cir. 2006) (“[W]e also should not normally interpret a claim term to exclude a preferred embodiment.”).

4. signal point (claims 9, 19)

> *Construction: a value that is transmitted by a modulator in one signaling interval*

The ’627 patent teaches that a transmitter uses a modulator to transmit signal points to the receiver. “The signal point . . . is passed on to modulator 128 to generate a pass-band line signal which is applied to the communication channel.” (Ex. 4 at 3:38-42.) Each signal point on the communication channel corresponds to a value transmitted in one signaling interval. The signal point generated in the “nth baud [or signaling] interval” is passed to the modulator for

transmission. (Ex. 4 at 2:21-28 and 3:38-42.) This is also shown by reference to the number of signal intervals that separate signal points on the communication channel during transmission. As one of many examples, the patent specification describes signal point x_1^α in the stream of signal points x_1^α, x_2^α, x_3^α, x_4^α, x_5^α, x_6^α as being separated from the signal point x_6^α by five signaling intervals, demonstrating that a signal point gets transmitted every signaling interval. (Ex. 4 at 2:21-28 and 6:58-61.)

Comcast asserts that a signal point is a point in a "signal constellation," apparently to limit signal points to values in a two dimensional modulation scheme such as quadrature amplitude modulation ("QAM"). Such a limitation is unwarranted. QAM is merely the modulation scheme used in the preferred embodiment of the '627 patent. As Comcast's own expert agreed, the term signal point has a much broader meaning, and can be used to refer to values in other modulation schemes. (Ex. 8 at 248:13-16 and 248:21-249:2.) For example, the art uses "signal point" to refer to the values in a one-dimensional modulation format known as VSB:

> "It should be noted that the input to an M-ary VSB modulator is a sequence of one-dimensional (P=1) ***signal points*** whereas the input into a QAM modulator is a sequence of two-dimensional (P=2) ***signal points***."

(U.S. Patent No. 5,706,312 (Ex. 22) at 3:10-14.) Comcast's expert agrees that this is an acceptable usage of the term "signal point." (Ex. 8 at 248:13-16 & 248:21-249:2).

Nothing in the '627 patent suggests a narrower meaning for "signal point," and Comcast's attempt to limit the claim to the preferred embodiment should be rejected.

5. distributed Viterbi decoder (claims 9. 19)

Construction: a Viterbi decoder having multiple Viterbi decoding processes operating on separate portions of a stream of data to be decoded

Rembrandt's construction of "distributed Viterbi decoder" gives the term its full scope supported by the patent specification. The distributed Viterbi decoder, in one embodiment, is shown as consisting of multiple separate Viterbi decoder stages. (Ex. 4 at Figure 4.) The patent

specification makes clear, however, that the distributed Viterbi decoder could be implemented in software as a decoder with a single stage that continually switches the input data to the decoder stage, making it function effectively as a decoder with multiple stages. Thus, the distributed Viterbi decoder could be implemented as a single software program that emulates the function of multiple physical devices:

> "[M]ultiple trellis encoders and decoders can be realized using a single program routine which, ***through the mechanism of indirect addressing of multiple arrays within memory***, serves to provide the function of each of the multiple devices."

(Ex. 4 at 9:61-66.) Comcast's expert admitted that such an implementation represents an embodiment of the invention of the '627 patent. (Ex. 8 at 254:1-255:8.)

Rembrandt's construction allows for this kind of decoder, consistent with the patent specification, while Comcast's construction unnecessarily limits the distributed Viterbi decoder to multiple, distinct "structures." Because the specification clearly teaches an invention that does not require such structures, Comcast's construction is incorrect.

6. means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols

Construction: interpreted under 35 U.S.C. §112, ¶ 6.

Function: to reverse the process of interleaving performed in the transmitter to recover multiple streams of trellis encoded channel symbols from the interleaved signal points

Structure: signal point deinterleaver 441 or switching circuit 431, or a software based deinterleaver or switching circuit, and equivalents

The first step in construing a means-plus-function claim limitation is to identify the corresponding function. *Lockheed Martin Corp. v. Space Systems/Loral, Inc.*, 324 F.3d 1308, 1318 (Fed. Cir. 2003). The essential difference between the competing "function" constructions is that Rembrandt has attempted to explain and clarify that deinterleaving is reversing the process of interleaving, while Comcast has merely repeated "deinterleaving" in its construction. Rembrandt submits that the clarification is helpful to understanding the term.

Turning next to the structure, the law is clear that §112, ¶6 does not permit incorporation of structure from the written description "beyond that necessary to perform the claimed function." *Micro Chem., Inc. v. Great Plains Chem. Co., Inc.,* 194 F.3d 1250, 1258 (Fed. Cir. 1999). Comcast's expert, however, admitted that Comcast's proposed construction incorporates more structure than was necessary to perform the recited function. (*See* Ex. 8 at 255:23-256:8 & 256:25-257:4.)

If the specification identifies multiple structures that can perform the function, then any of those structures may be the corresponding structure. *Creo Prods., Inc., v. Presstek, Inc.,* 305 F.3d 1337, 1345 (Fed. Cir. 2002). The '627 patent identifies a variety of structures that can perform the recited deinterleaving function: (1) Signal point deinterleaver 441, which deinterleaves received signal points (Ex. 4 at 5:67-6:16); (2) switching circuit 431, which performs channel symbol deinterleaving (Ex. 4 at 5:67-6:16); and (3) "an appropriately programmed processor" that performs the functions of the signal point deinterleaver or switching circuit (Ex. 4 at 9:60). Accordingly, any one of these structures may serve as the corresponding structure in the construction of this claim element.

III. CONCLUSION

For the reasons set forth above, Rembrandt's proposed claim constructions should be adopted.

Case 2:07-cv-00398-TJW Document 13-11 Filed 01/18/2007 Page 41 of 42

Dated: December 27, 2006

Respectfully submitted,

FISH & RICHARDSON P.C.

By: /s/ Andrew W. Spangler

Otis Carroll
State Bar No. 03895700
Wesley Hill
State Bar No. 24032294
IRELAND, CARROLL & KELLEY, P.C.
6101 S. Broadway, Suite 500
Tyler, TX 75703
Tel: (903) 561-1600
Fax: (903) 581-1071
Email: fedserv@icklaw.com

Frank E. Scherkenbach
Lawrence K. Kolodney
Michael H. Bunis
Thomas A. Brown
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, MA 02110
Tel: 617-542-5070
Fax: 617-542-8906

Timothy Devlin
FISH & RICHARDSON P.C.
919 N. Market Street, Suite 1100
Wilmington, DE 19899-1114
Tel: 302-652-5070
Fax: 302-652-0607

Alan D. Albright
State Bar # 00973650
FISH & RICHARDSON P.C.
One Congress Plaza, 4th Floor
111 Congress Avenue
Austin, TX 78701
Tel: 512-391-4930
Fax; 512-591-6837

Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the above and foregoing document has been served on the 27th day of December to all counsel of record who are deemed to have consented to electronic service via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

Brian L. Ferrall, Esq. Leo L. Lam, Esq. Eric MacMichael, Esq. Keker & Van Nest, L.L.P. 710 Sansome Street San Francisco, CA 94111-1704	Attorneys for Defendants Comcast Corporation, Comcast Cable Communications, LLC and Comcast of Plano, LP
Jennifer Haltom Doan, Esq. John Peyton Perkins, III, Esq. Haltom & Doan, LLP 6500 N. Summerhill Road Crown Executive Center, Suite 1A P. O. Box 6227 Texarkana, TX 75505-6227	Attorneys for Defendants Comcast Corporation, Comcast Cable Communications, LLC and Comcast of Plano, LP

/s/ Andrew W. Spangler
Andrew W. Spangler

21510263.5.doc

Exhibit 1

US005719858A

United States Patent [19]

Moore

[11] Patent Number: 5,719,858

[45] Date of Patent: Feb. 17, 1998

[54] TIME-DIVISION MULTIPLE-ACCESS METHOD FOR PACKET TRANSMISSION ON SHARED SYNCHRONOUS SERIAL BUSES

[75] Inventor: **Wayne T. Moore**, Clearwater, Fla.

[73] Assignee: **Paradyne Corporation**, Largo, Fla.

[21] Appl. No.: **509,309**

[22] Filed: **Jul. 31, 1995**

[51] Int. Cl.[6] **H04B 7/212**

[52] U.S. Cl. **370/347**; 370/349; 370/442; 370/458; 370/468; 340/825.5

[58] Field of Search 370/349, 331, 370/335, 355, 442, 462, 461, 460, 463, 352, 353, 468, 447, 405, 458, 347; 340/825.5

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,445,213	4/1984	Baugh et al.	370/405
4,611,321	9/1986	Gabrielli et al.	370/352
4,750,168	6/1988	Trevitt	370/462
4,763,321	8/1988	Calvignac et al.	370/352
5,124,983	6/1992	Landez et al.	370/447
5,463,624	10/1995	Hogg et al.	370/461

Primary Examiner—Wellington Chin
Assistant Examiner—Melissa Kay Carman
Attorney, Agent, or Firm—Thomas, Kayden, Horstemeyer & Risley

[57] **ABSTRACT**

A plurality of packet data sources, e.g., packet application modules, and synchronous data sources, e.g., synchronous application modules, are coupled to the same TDM bus for communicating data to a network access module. A portion of the bandwidth, or time-slots, of the TDM bus is allocated as a multiple-access packet channel that is shared among the packet application modules. As a result, the network access module receives a single, continuously multiplexed, packet stream for transmission to an opposite endpoint. Packet application modules on the TDM bus contend for this multiple access packet channel when transmitting to the opposite endpoint. In the receiving direction, each packet application module accepts the entire received packet stream from the network access module and may either filter the packets using their address field or may transparently forward the data to a packet service.

32 Claims, 4 Drawing Sheets

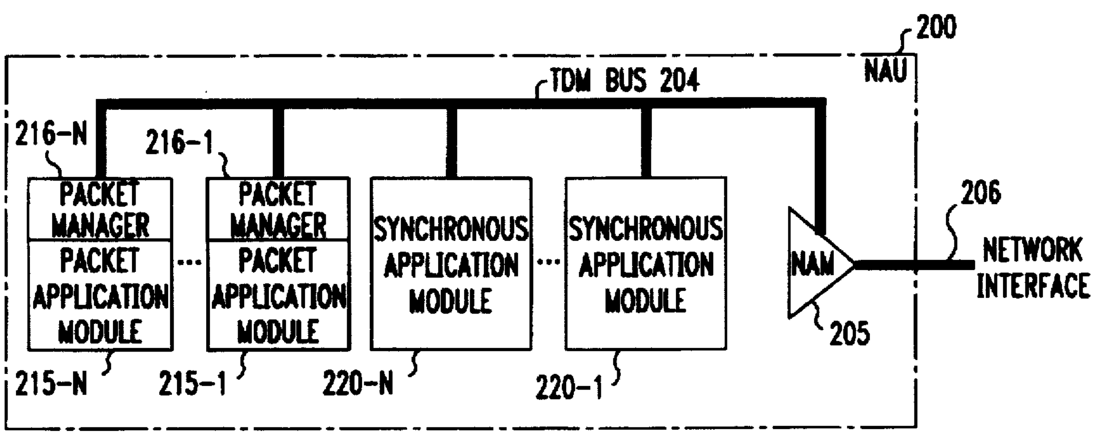


FIG. 1
PRIOR ART

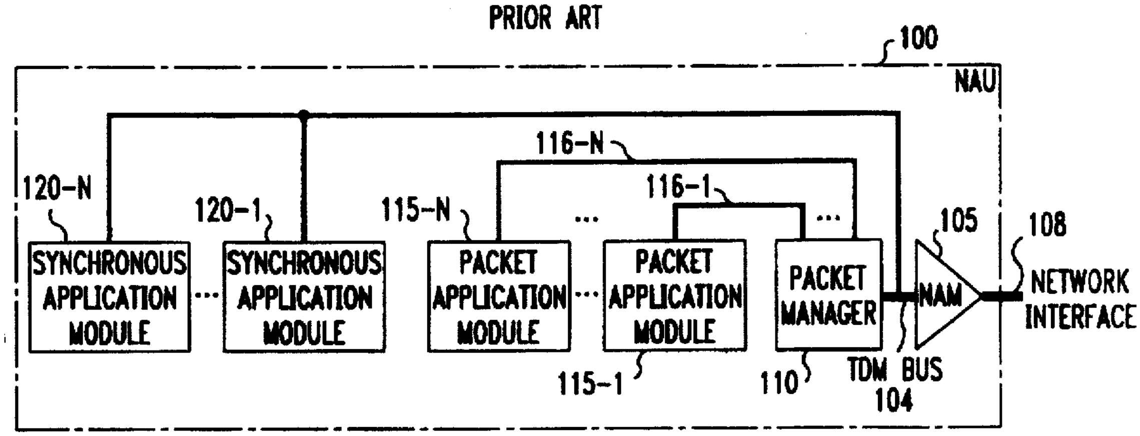


FIG. 2
PRIOR ART

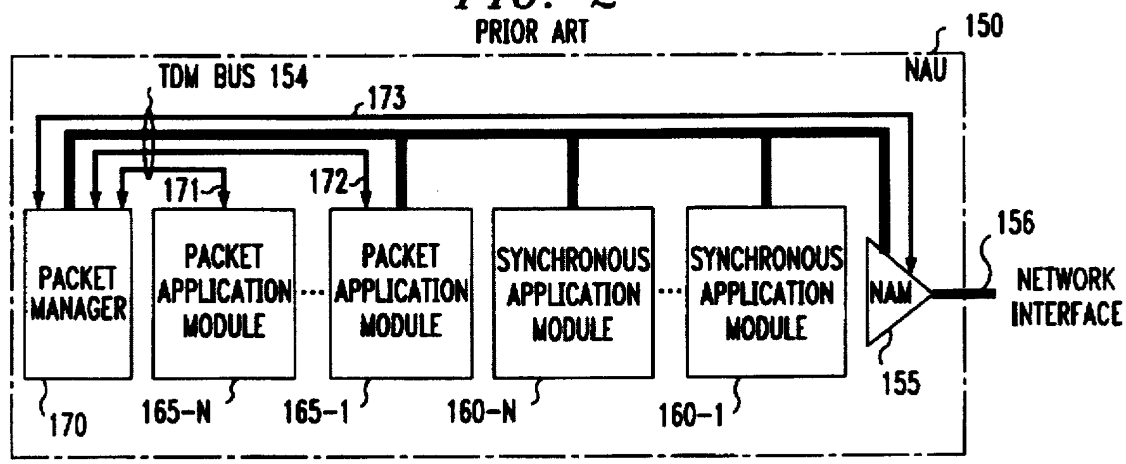


FIG. 3

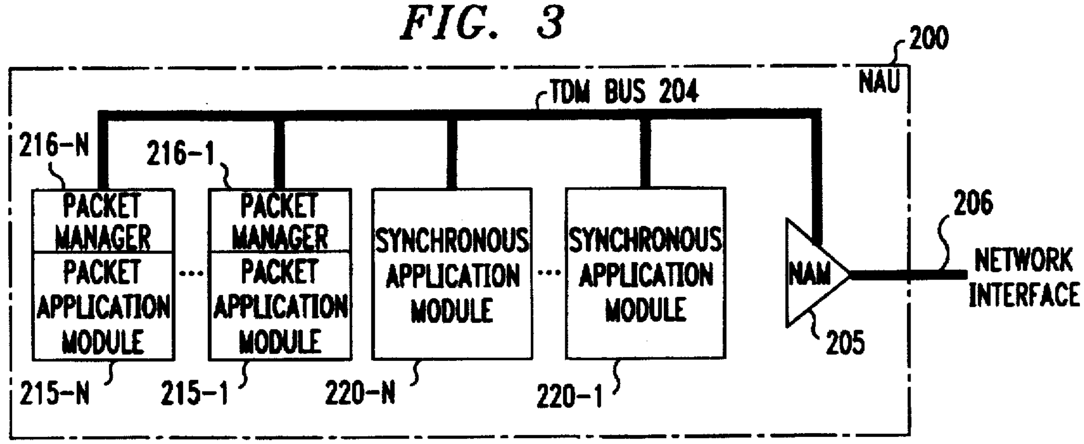


FIG. 4

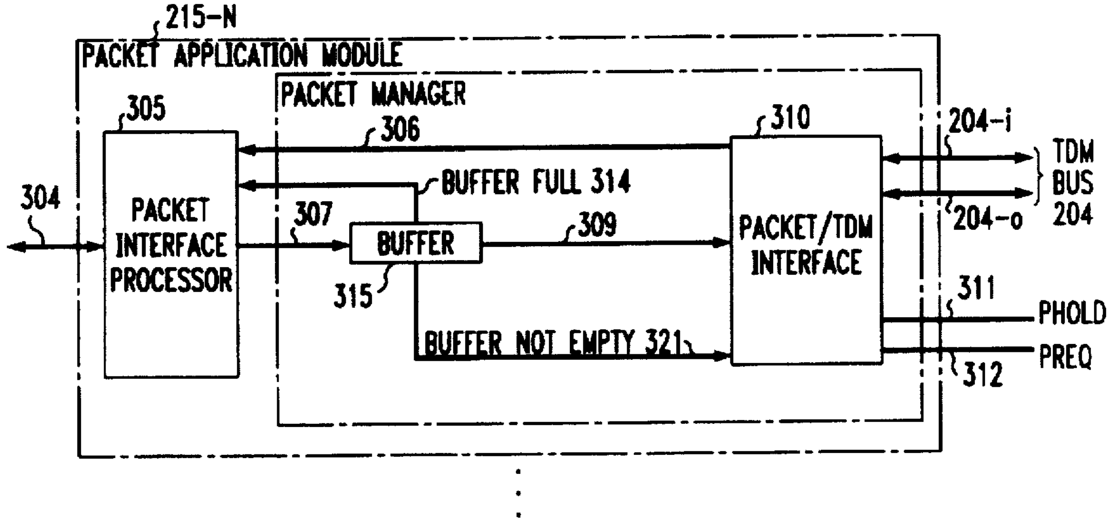

215-N
PACKET APPLICATION MODULE
PACKET MANAGER
305
306
310
204-i
TDM BUS 204
304
PACKET INTERFACE PROCESSOR
BUFFER FULL 314
307
BUFFER
309
PACKET/TDM INTERFACE
204-o
315
311
PHOLD
BUFFER NOT EMPTY 321
PREQ
312

FIG. 5

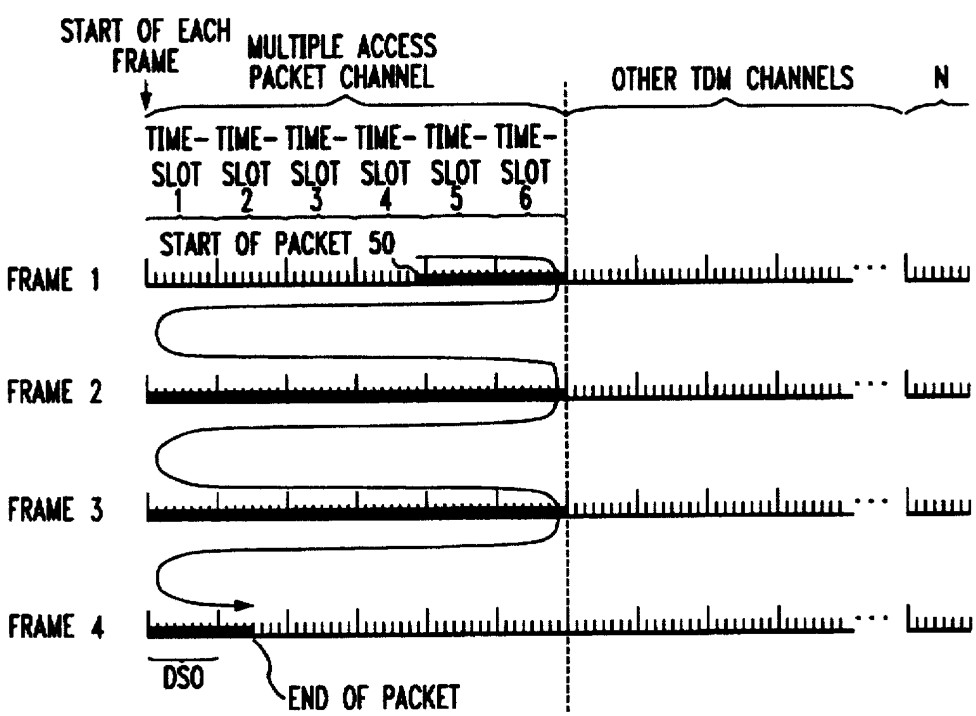
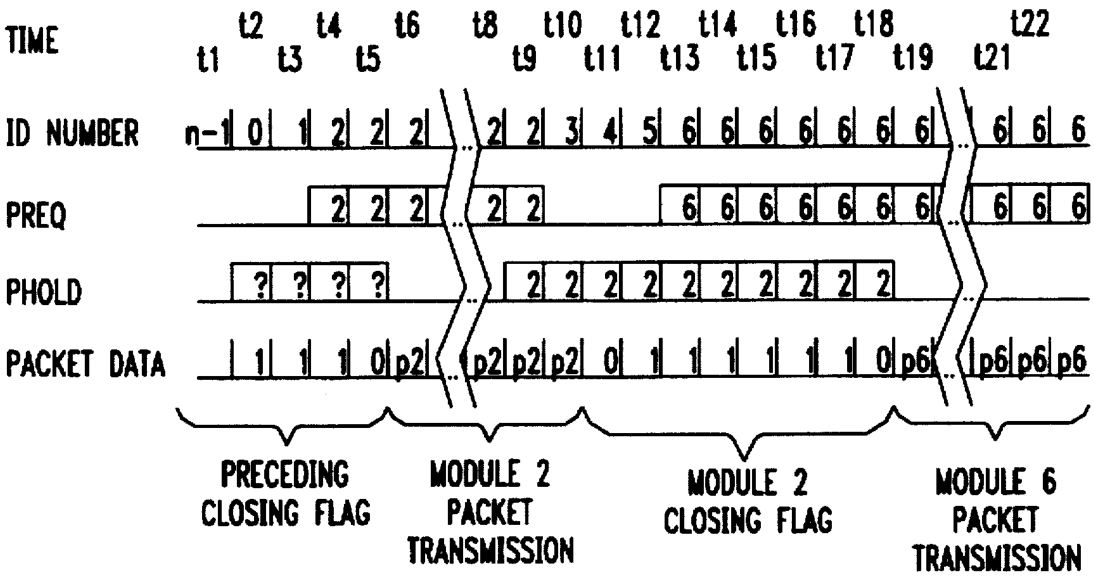
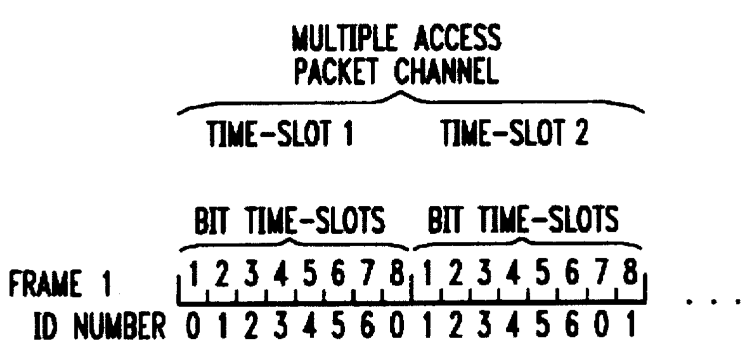

START OF EACH FRAME
MULTIPLE ACCESS PACKET CHANNEL
OTHER TDM CHANNELS
N
TIME-SLOT 1
TIME-SLOT 2
TIME-SLOT 3
TIME-SLOT 4
TIME-SLOT 5
TIME-SLOT 6
START OF PACKET 50
FRAME 1
FRAME 2
FRAME 3
FRAME 4
DSO
END OF PACKET

FIG. 6



TIME
t1 t2 t3 t4 t5 t6 t8 t9 t10 t11 t12 t13 t14 t15 t16 t17 t18 t19 t21 t22
ID NUMBER
PREQ
PHOLD
PACKET DATA
PRECEDING CLOSING FLAG
MODULE 2 PACKET TRANSMISSION
MODULE 2 CLOSING FLAG
MODULE 6 PACKET TRANSMISSION

FIG. 7



MULTIPLE ACCESS PACKET CHANNEL
TIME-SLOT 1
TIME-SLOT 2
BIT TIME-SLOTS
BIT TIME-SLOTS
FRAME 1
1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8
ID NUMBER 0 1 2 3 4 5 6 0 1 2 3 4 5 6 0 1

FIG. 8A

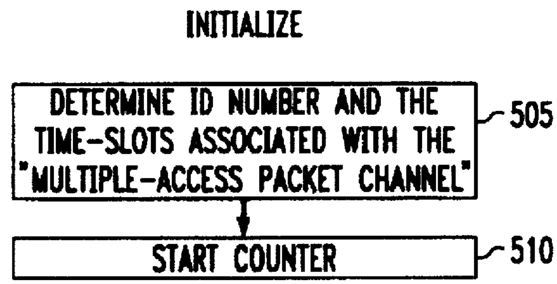


FIG. 8B

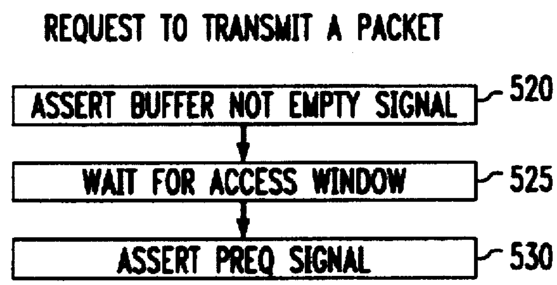
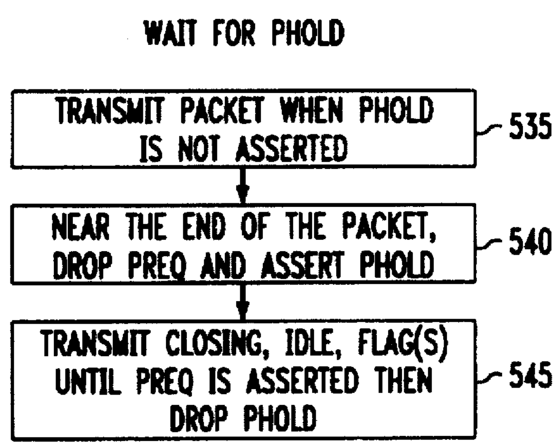


FIG. 8C



TIME-DIVISION MULTIPLE-ACCESS METHOD FOR PACKET TRANSMISSION ON SHARED SYNCHRONOUS SERIAL BUSES

BACKGROUND OF THE INVENTION

The present invention relates to data communications, and more particularly, to communications systems that have channelized network access, and may transport both synchronous data and variable-bit-rate data such as frame relay (hereafter referred to as packet data), in a time-division multiplexed format.

Communications equipment horn as a "network access unit" (NAU) typically provides frame-relay-type services between a local communications network and a network facility, like a T1 facility. The NAU messages the flow of data between the local communications network and the network facility in both directions. To provide the most flexibility, it is preferable that the NAU support two types of data: synchronous data and packet data. For example, the support of synchronous data provides the ability to make telephone, i.e., voice, calls, while the support of packet data provides the ability to interwork with public network packet services. However, the asynchronous nature of packet data at the logical level combined with the requirements of synchronous data causes design tradeoffs in both the complexity and cost of an NAU.

One prior art approach of designing an NAU to support both synchronous data and packet data is shown in FIG. 1. NAU **100** includes network access module **115-1** **105**, synchronous application modules **120-1** to **120**-n, packet application modules **115-1** to **115**-n, and packet manager **110**. NAM **105** provides the interface between time-division-multiplexing (TDM) bus **104** and network facility **106**, which is representative of a T1 facility. The synchronous application modules couple synchronous data equipment (not shown), e.g., telephone equipment, to NAM **105** via TDM bus **104**. The packet application modules couple packet data equipment (not shown), e.g., a data terminal, to packet manager **110**. The later is a common resource module that performs internal aggregation in one direction, and distribution in the other direction, of packet streams between NAM **105** and each packet application module, via TDM bus **104** and wideband packet buses **116-1** to **116**-n, respectively. In this context, each wideband packet bus is transmitting packet data in parallel, e.g., a "byte" at a time, in contrast to TDM bus **104**, which is a serial bus, i.e., it transmits data a bit at a time. As a reset of coupling the packet data to the TDM bus, packet manager **110** provides a single multiplexed packet stream to NAM **105** for transmission across the network interface. It should be understood that the network interface bandwidth is "channelized" and, in the context of packet data, expects a single multiplexed packet stream.

NAU **100** is representative of a mixed TDM and packet NAU architecture. In this approach, NAU **100** provides a TDM bus in conjunction with one or more packet buses which taken together provide more bandwidth than is required to support the network interface. This additional bandwidth is used to support multiple point-to-point packet connections. Packet manager **110** not only aggregates the packet data, as mentioned above, but also allocates a fixed amount of the TDM bandwidth to the packet application modules.

Unfortunately, the instantaneous, or peak, data rate of all outbound packet streams taken together may be greater than the "fixed amount of TDM bandwidth" allocated for packet

data on the network interface. These peak data rates create a large demand on both the overall packet bus capacity and on the packet handling requirements of packet manager **110**. For example, once the packet application modules exceed their allocated network interface bandwidth, packet manager **110** must take steps to prevent the loss of any packet data. These steps include buffering the packet data, which may require a buffer of considerable size to support all of the packet application modules, and, perhaps, flow control to throttle the packet traffic. As a result, the complexity of packet manager **110** increases not only with the number of packet application modules that packet manager **110** must support but also with the respective data rate requirements of these packet application modules.

Another prior art approach is illustrated in FIG. 2, which is similar to FIG. 1 except that separate point-to-point wideband packet buses have been replaced with separate TDM channels between each packet application module and the packet manager. In particular, packet application modules **165-1** to **165**-n are coupled to TDM bus **154**, along with packet manager **170**. Each packet application module communicates data to, and from, packet manager **170** in a separate TDM channel as represented by lines **171** and **172**. Like the description above for FIG. 1, packet manager **170** aggregates the packet traffic to NAM **155** via a TDM channel, as represented by line **173**, to create a single multiplexed packet stream.

Unfortunately, this approach has the above-mentioned problems with respect to the packet manager and, in addition, drives up the bandwidth requirement of the TDM bus. For example, the TDM bus must now support the peak rate of each packet application module on each TDM channel in addition to a TDM channel for the aggregate packet data stream provided by packet manager **170**. Conversely, if the TDM channels are limited to a fixed fraction of the allocated network interface bandwidth, a single packet application module would never be able to peak near the full rate when other packet application modules have little or no traffic.

SUMMARY OF THE INVENTION

I have realized an alternative approach to the design of TDM-based equipment that supports both synchronous data and packet data and, in addition, provides an efficient substrate for packet handling. In particular, multiple packet data sources share a single TDM channel. As a result, no central packet manager is required to aggregate the packet data.

In an embodiment of the invention, a plurality of packet data sources, e.g., packet application modules, and synchronous data sources, e.g., synchronous application modules, are coupled to the same TDM bus for communicating data to a network access module. In particular, a portion of the TDM bandwidth allocated to packet data is treated as a "multiple-access packet channel." This allows packet application modules on the TDM bus to share, and contend for, the entire TDM bandwidth allocated to packet data. Each packet application module includes its own TDM bus interface and the network access module receives a single, continuously multiplexed, packet stream for transmission to an opposite endpoint. In the receiving direction, each packet application module accepts the entire received packet stream from the network access module and either filters the packets using their address field or transparently forwards the packet data to a packet service.

In a feature of the invention, a contention scheme for accessing the "multiple-access packet channel" is described

that avoids packet collisions, maximizes bandwidth efficiency, and provides for interframe High-level Data Link Control (HDLC) flags.

This invention provides the following advantages: no central packet manager is required to synchronize packet data to the TDM bus; packet sources share all of the TDM bandwidth allocated to packet data resulting in maximum efficiency; there is no additional overhead required for packet addressing on the bus; packet buffering is distributed across the bus, rather than being fixed in a central location; and the system has "modularity" and can quickly grow simply by adding additional packet application modules.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows a block diagram of a prior art mixed TDM and packet network access unit;

FIG. **2** shows a block diagram of another prior art time-division-multiplexing-only network access unit;

FIG. **3** shows an illustrative block diagram of a time-division-multiplexing-only network access unit in accordance with the principles of the invention;

FIG. **4** shows a block diagram of a packet application module in accordance with the principles of the invention;

FIG. **5** shows a representation of a sequence of time-division-multiplexing frames in accordance with the principles of the invention;

FIG. **6** is an illustration of a packet arbitration scheme for use in the network access unit of FIG. **2** in accordance with the principles of the invention;

FIG. **7** is an illustration of counting bit time-slots in the "multiple-access packet channel;" and

FIGS. **8A–8C** are illustrative flow diagram of a method in accordance with the principles of the invention for use in the packet application module of FIG. **4**.

DETAILED DESCRIPTION

An illustrative block diagram of an NAU embodying the principles of this invention is shown in FIG. **3**. NAU **200** provides access to a T1 facility for frame relay services as well as synchronous data transport. For simplicity, data endpoints, synchronous or packet, are not shown. NAU **200** includes network access module (NAM) **205**, synchronous application modules **220-1** to **220**-n, and packet application modules **215-1** to **215**-n. NAM **205** provides the interface between TDM bus **204** and network facility **206**, which is representative of a T1 facility. The synchronous application modules couple synchronous data equipment (not shown), e.g., telephone equipment, to NAM **205** via TDM bus **204**, as is known in the art. In accordance with the inventive concept, multiple packet application modules now share a single TDM channel (described below). Each of the plurality of packet application modules couple packet data equipment (not shown), e.g., a data terminal, to TDM bus **204**, and the packet manager is eliminated. Indeed, the function of the packet manager is now distributed among the various packet application modules that created the need for it in the first place. This distribution of the packet manager is represented by the inclusion of packet managers **216-1** through **216**-n in the respective packet application modules.

A block diagram of illustrative packet application module **215**-n is shown in FIG. **4**. Other than the inventive concept, the components of packet application module **215**-n are well-known and will not be described in detail. Packet application module **215**-n includes packet interface processor **305**, buffer **315**, and packet/TDM interface **310**. The latter is an "application specific integrated circuit" (ASIC), which is a programmable large-scale integrated circuit device that is dedicated to performing a specific function, or application, which in this case is described below. Packet interface processor **305** communicates packet data between packet/TDM interface **310** and line **304**. The latter is representative of any one of a number of facilities for coupling packet application module **215**-n to a packet system. For example, line **304** could be a local area network, or a dedicated facility to a "router" or a packet data terminal. Packet interface processor **305** performs packet handling, e.g., it provides the physical and link layer connections for packet transmission as known in the art, e.g., it checks for addresses, errors, etc., on the packets. Packet data transmitted to a far-end packet endpoint is provided from packet interface processor **305** to packet/TDM interface **310** via line **307**, buffer **315**, and line **309**. It is assumed that lines **307** and **309** are representative of wideband data buses as known in the art. In the other direction, packet data from a far-end packet endpoint is received by packet interface processor **305** from packet/TDM interface **310** via line **306**. Packet interface processor **305** receives a BUFFER FULL signal via line **314** from buffer **315**, which provides a BUFFER NOT EMPTY signal via line **321** to packet/TDM interface **310**. In accordance with the principles of the invention, packet/TDM interface **310** synchronizes packet data retrieved from buffer **315** for insertion into an appropriate time slot on TDM bus **204**. The latter is shown as actually comprising two TDM buses. TDM bus **204**-o is used for "outbound" traffic through NAM **205** to network interface **206**. Conversely, TDM bus **204**-i is used for "inbound" traffic from the network. Typically, in the art, TDM bus **204**-i and **204**-o are symmetrical, e.g., if time-slot **0** is used for status and control information on the "inbound" TDM bus, time-slot **0** of the "outbound" TDM is similarly used for status and control information.

The storage size of buffer **315** is determined empirically and is a function of the type of packet equipment and its data rate. For example, if a packet application module is interfacing to a router, as known in the art, a router may communicate packet data on the order of 128 Kb/sec. Consequently if the packet application module cannot, for the moment, transmit a packet from the router to the TDM bus, the packet application module can perform flow control with the router with a concomitant minimal amount of buffering required on the packet application module because of the low data rate from the router. Conversely, if a packet application module is interfacing to a LAN, which typically communicates data at a higher speed, e.g., 10 Mb/sec., a larger amount of buffering may be required on the packet application module. Thus, depending on the packet equipment, each packet application module may have different buffering requirements—but each packet application module has less buffer requirements than the packet manager module of the prior art.

In accordance with the invention, a portion of the bandwidth of TDM bus **204** is pre-assigned to all the packet data. In particular, this packet-dedicated portion of the bandwidth is referred to herein as a "multiple-access packet channel," which is shared among at least two of the packet application modules. This is in contrast to allocating a fixed fraction of the TDM bandwidth to each packet application module. The "multiple-access packet channel" provides a single channel for communicating all packet data to, or from, NAM **205**. In effect, this "multiple-access packet channel" resembles a packet "local area network" (LAN) in many respects, except that the bandwidth of the "multiple-access packet channel"

is closely matched (or equal) to that allocated for packet traffic across network facility **206**. In this case, each packet application module must contend for the bandwidth of the "multiple-access packet channel" with the other packet application modules. (Although, the nature of a TDM bus prevents any packet application module from using more bandwidth than is available from the network, this approach makes the entire network bandwidth allocated to packet data dynamically available to each packet application module as a channel for the transport of packet data.)

NAM **205** communicates to all application modules and controls time-slot allocation among the synchronous modules and the packet modules. The control of time-slot allocation can be performed either over TDM bus **204** or another bus (not shown). In this example, it is assumed that a portion of the TDM bus bandwidth is allocated to control and status information, as known in the art. In accordance with the principles of the invention, the time-slots allocated by NAM **205** to the packet application modules are the "multiple-access packet channel."

In this example, it is assumed that every time-frame is comprised of a plurality of 64 Kbit (DS**0**) channels, and it is assumed that the "multiple-access packet channel" is any grouping of these DS**0** channels. Although not a requirement, it is also assumed that the "multiple-access packet channel" is composed of a subset of contiguous DS**0** channels available on the bus. In this case, this corresponds to time-slots **1**, **2**, **3**, **4**, **5**, and **6**, of every frame. The remaining time-slots are allocated to synchronous data and control/status information. The allocation of the above-mentioned six time-slots yields a "multiple-access packet channel" with a bandwidth of 384 Khz. The number of DS**0** channels allocated on the inbound and outbound data highways are assumed to the be same, so that equal bandwidth is assured in both directions. (As described above, it is assumed that TDM bus **204**-i and TDM bus **204**-o are symmetrical, i.e., time-slots **1** through **6** are used for the "multiple-access packet channel" for inbound and outbound traffic.) Finally, it is assumed that this 384 Khz bandwidth is equal to the bandwidth allocated over the network facility for the same packet traffic, i.e., NAM **205** is not required to buffer the packet data.

In accordance with a feature of the invention, it is assumed that packet transmission is utilizing HDLC, which is a bit-oriented layer **2** protocol that produces variable bit length packets. This allows a packet to be spread across time-slots and multiple TDM frames. The "multiple-access packet channel" in this case can be considered a continuous sequence of bits with no framing boundaries other than those of the protocol. As such, the starting point of a packet may lie anywhere in the "multiple-access packet channel." An illustrative sequence of frames is shown in FIG. **5**. Frame **1** includes time slots **1** through N, where, as mentioned above, each time-slot represents a 64 Kbit DS**0** channel. In this example, it is assumed that N is equal to 64 time-slots. Each frame repeats every 125 micro-seconds and each time-slot is further broken down into a sequence of 8 bits as shown in FIG. 5. Each bit is hereafter referred to as a "bit time-slot." It should be noted that the term "time-slot" refers to a collection of "bit time-slots." Time-slots **1–6** represent the "multiple-access packet channel." As described above, since HDLC is a bit-oriented layer **2** protocol, this allows the packet data to begin and end anywhere in a time-slot. Consequently, each packet is mapped into a plurality of "bit time-slots" within time-slots **1** through **6** on TDM bus **204**, rather than the DS0 channels representing each time-slot as a whole. This is illustrated in FIG. **5**, where packet **50** begins with "bit time-slot" **7** in time-slot **4**, of frame **1**, and ends with "bit time-slot **3**" in time-slot **2** of frame **4**. As illustrated by the starting and ending time of packet **50**, of FIG. **5**, these bit intervals do not have to conform to time slot boundaries into which the packets are mapped and inserted.

As described above, each packet application module must contend for the "multiple-access packet channel." If a packet application module "grabs" the "multiple-access packet channel" that packet application module then transmits using the full 384 Khz of bandwidth. However, if a packet application module cannot "grab" the "multiple-access packet channel," then that packet application module must queue, or buffer, the packet. As a result, the flow control is now distributed among the packet application modules.

The properties desired for packet transport on the "multiple-access packet channel" are high bandwidth efficiency and deterministic fairness. Bandwidth efficiency is a measure of how closely the packet utilization oft he available (fixed) TDM bandwidth matches the offered packet load. It also measures efficiency of the channel as the offered packet load exceeds the available bandwidth. Fairness describes how a chosen priority scheme affects the comparative delay of packets through the system under bandwidth contention with multiple packet sources.

Any method used for implementing a "multiple-access packet channel" should be designed to achieve as close to 100% bandwidth efficiency as possible with no negative throughput effects due to congestion. The method should also have no inherent priority bias among the packet sources so that priorities may be enforced selectively if needed, preferably in software on the packet application modules. These properties are only applicable to the outbound (toward the network) direction, where multiple packet sources are contending for a fixed network pipe. Inbound packet data is already multiplexed as a single packet stream within the network channel. Since the TDM bus **204** is full duplex, as represented by separate data highways TDM bus **204**-i and TDM bus **204**-o, NAU **200** may have an asymmetric access protocol. That is, the access protocol for the inbound direction can be different from the access protocol described below for the outbound direction. In the context of this invention, it is assumed that all modules are continually listening to the TDM in-bound bus to pull off data addressed to them. In the case of the packet application modules, it is assumed that each packet application module is monitoring, or listening to, the "multiple-access packet channel" for packets that have addresses associated with that packet application module. A packet application module listens for its header, e.g., virtual address, if it is not their packet, it is just dropped. The remainder of this description will focus on outbound packet traffic.

In accordance with the invention, a Time-division Multiple Access with Collision Avoidance (TDMA/CA) scheme is used for the outbound direction to regulate access to the "multiple-access packet channel." In particular, the synchronous property of TDM bus **204** provides the means to implement a slotted-access method to avoid collisions. This slotted-access method enables each packet application module to contend for the "multiple-access packet channel," and avoid packet collisions, in a fair and efficient manner. In this embodiment, the slotted-access method is implemented by packet/TDM interface **310** of each packet application module.

Before describing it in detail, an overview of this slotted-access method is described. In the slotted-access method, each packet application module, in rotation order, is given an

"access window" of time, corresponding to a "bit time-slot" on the TDM bus, to either capture the "multiple-access packet channel" for transmission, or defer and allow the "access window" to advance to the next packet application module in order. Once granted access, that packet application module has sole access to the "multiple-access packet channel" for a period of time, referred to herein as the "access period." During this "access period," a packet application module sends at least one HDLC frame of queued packet traffic toward the network, and the "access window" is frozen at the current packet application module and does not advance until that packet application module releases the "multiple-access packet channel." Under some conditions however, a packet application module may not begin transmitting packet data as soon as it has captured the "multiple-access packet channel." In particular, whenever the previously transmitting packet application module is still transmitting a packet or closing flag, the next packet application module must wait until completion before transmitting its first packet. Since a rotational arbitration scheme on the bus may take several "bit time-slots," or clock, intervals, this mechanism allows the arbitration to overlap an active packet transmission, avoiding idle time on the bus and increasing bandwidth utilization.

FIG. **6** shows an illustrative slotted-access method. There is an implied numbering of the packet application modules and "bit time-slots." This implied numbering is hereafter referred to as an "ID number." Generally speaking, a packet application module can attempt to access TDM bus **204**-o only when the ID number of the "bit time-slot" matches the ID number of the packet application module. In a system with N packet application modules, each "bit time-slot" of the "multiple-access packet channel" is counted in a repeating sequence from 0 to N−1 starting at some arbitrary "bit time-slot" by each packet application module. In other words, each packet application module only counts those "bit time-slots" assigned to the "multiple-access packet channel." The value of the count is the ID number for the "bit time-slot." All packet application modules are synchronized with this counting sequence and are aware of the ID number of each "bit time-slot" at all times. As a result, the ID number need not be present on the bus. As noted earlier, each packet application module knows, a priori, the time-slots associated with the "multiple-access packet channel." In combination with this, each packet application module is configured with an unique ID number, which can be determined in any number of ways. For example, each module, or circuit board, can have an address associated either via a "software-controlled" configuration, e.g., a system administer literally assigns addresses to the various modules; or by a hardware setting that specifically associates a particular address with a particular position in the system, e.g., what slot the circuit board is plugged into. Note, this counting of "bit time-slots" may span more than one frame. Since N may be any integer there is no relationship between this ID numbering and the position of bits in the TDM frame.

For example, if there are seven packet application modules, and assuming for the moment that none of the seven packet application modules wanted access to the TDM bus, this counting would look like that shown in FIG. **7**. FIG. **7** is similar to FIG. **5**, except packet **50** has been removed, i.e., there is no transmission of a packet and only time-slots **1** and **2** of frame **1** are shown. It is assumed that each packet application module counts "bit time-slots" of the "multiple-access packet channel" beginning with "bit time-slot" **1** of frame **1**, which is associated with the count value of 0. Each packet application module waits for its ID number to equal the count, or ID number, of the "bit time-slot" to attempt to access TDM bus **204**-o. For example, the packet application module associated with ID **0**, can attempt access only upon the value of the count equaling 0, which, in this example, occurs in "bit time-slot" **1** of time-slot **1** of frame **1**, "bit time-slot" **8** of time-slot **1** of frame **1**, "bit time-slot" **7** of time-slot **2** of frame **1** etc.

To implement this slotted-access method two additional signals are bussed between packet application modules. These signals are "packet request" (PREQ) and "packet hold" (PHOLD). It is assumed these signals are bussed among the packet application modules as simply "open collector" as known in the art which allows them to be logically "OR"ed. Referring back to FIG. **6**, a sequence of "bit time-slots" is shown. This sequence of bit time-slots only represents those "bit time-slots" assigned to the "multiple-access packet channel." The top row of FIG. **6** is simply a sequence of bit time reference points. The second row of FIG. **6** is the ID number of the "bit time-slot" of the "multiple-access packet channel," i.e., the value of the count. The next two rows represent the state of the PREQ and PHOLD busses. The final row simply represents packet data.

Beginning at time **t2**, the "bit time-slot" ID number is equal to 0. In order for a packet application module to transmit a packet on TDM bus **204**-o, the packet application module must assert the PREQ signal whenever the ID numbers of the "bit time-slot" and the packet application module match. Upon receiving the PREQ signal, each packet application module halts the counting. The packet application module that asserted the PREQ signal becomes the next in line to begin transmission. For example, when the packet application module associated with the ID number of 2 wants to transmit, it must wait until time **t4**, when the ID numbers of the "bit time-slot" and the packet application module match, to assert the PREQ signal. However, the presence of a PHOLD signal driven by the currently transmitting packet application module delays the access of packet application module **2** to TDM bus **204**-o until PHOLD is withdrawn at time **t5**. (The question marks illustrated in FIG. **6** simply represent that another, unidentified packet application module is currently transmitting.) At the next "bit time-slot," **t6**, packet application module **2** concatenates its packet stream with that of the previous transmission.

Although it could occur at any point, it is assumed that packet application module **2** drops the PREQ signal at the end of its packet transmission (described below) to allow the counting of time-slots by all packet application modules to again advance. At the same time, packet application module **2** asserts the PHOLD signal, which prevents the next packet application module from beginning its transmission until packet application module **2** has completed its closing flag sequence. These events occur at time **t9**. Subsequently, packet application module **6** raises it PREQ signal at time **t13**, signaling its readiness to send at least one packet, while packet application module **2** is still transmitting its closing flag. At time **t18**, packet application module **2** completes its packet transmission and drops PHOLD. At time **t19**, packet application module **6** begins sending its packet data.

It should be noted that the HDLC flags are a byte in length. Consequently, transmission of an HDLC inter-frame flag must end first before another packet application module can get the TDM bus **204**-o to insert data. In addition, and in accordance with HDLC, the last packet application module may continue inserting the inter-frame flags, and asserting the PHOLD signal until the PREQ signal is asserted, by

itself or another module. Once the PREQ signal is asserted, TDM/packet interface **310** drops the PHOLD signal only when the insertion of the current flag is finished.

As mentioned above, the point at which an actively transmitting packet application module asserts the PHOLD signal and lowers the PREQ signal is arbitrary. The earlier this occurs, the higher the probability that the next packet application module will be found by the time the first closing flag sequence is sent. This increases the efficiency of the "multiple-access packet channel" because there is no waiting for data transmission to finish to start arbitration again, i.e., no time is lost for contention (a packet application module is always ready to go). On the other hand, waiting until near the end of the transmission allows more timely packet queue information to be used in the arbitration. A balance between these two extremes could be implemented.

A method illustrating this slotted-access technique for use in the packet application module of FIG. **4** is shown in FIG. **8**. The steps shown in FIG. **8** have been divided into different "subroutines" for simplicity, i.e., an "initialize subroutine" (FIG. **8A**), "request to transmit a packet subroutine" (FIG. **8B**), and a "wait for PHOLD" subroutine (FIG. **8C**). In step **505**, packet application module **215**-n is initialized, e.g., via a power-up sequence, and determines its ID number, e.g., via a hardware strap or software configuration. During this initialization, NAM **205** of FIG. **3** allocates the time-slots associated with the "multiple-access packet channel." Packet/TDM interface **310** uses the assignment information from NAM **205** as the synchronizing signal to begin counting "bit time-slots" of the "multiple access packet channel" in step **510** (provided that the PREQ signal is not asserted). In this example, it is assumed that packet/TDM interface **310** includes a counter to count each "bit time-slot" of TDM bus **204**-o that is associated with the "multiple-access packet channel." The counter included within packet/TDM interface **310** rims continuously and is controlled by the PREQ signal, i.e., if PREQ is asserted—no counting takes place and the count holds at the last value.

When there is a packet to transmit, packet interface processor **305** begins to fill buffer **315** provided buffer **315** is not full. In particular, referring briefly back to FIG. **4**, it can be seen that a BUFFER FULL signal is provided by buffer **315** to packet interface processor **305**. This signal alerts packet interface processor **305** if buffer **315** is full. As a result, packet interface processor **305** fills buffer **315** when packet data is available to transmit only if the BUFFER FULL signal is not active. Once the BUFFER FULL signal is active, packet interface processor **305** could, if necessary, perform flow-control, if possible, with the associated packet endpoint like a router, or simply begin dropping packets. Assuming buffer **315** is initially empty, as packet interface processor **305** begins to fill up buffer **315**, the BUFFER NOT EMPTY signal is asserted for TDM/packet interface **310** in step **520**, via line **321**.

Upon receiving the BUFFER NOT EMPTY signal, TDM/packet interface **310** waits for the "access window" in step **525**. Once the "access window" matches, i.e., the ID number of packet application module **215**-n matches the current value of the counter, i.e., the "bit time-slot" ID number, TDM/packet interface **310** asserts the PREQ signal in step **530**.

In step **535**, TDM/packet interface **310** waits until PHOLD is no longer asserted before transmitting the packet from buffer **315** onto TDM bus **204**-o. Upon nearing the end of the packet transmission (which can be determined simply by knowing the length of the packet from the packet header information), TDM/packet interface **310** drops the PREQ signal and asserts the PHOLD signal in step **540**. As mentioned above, the last packet application module to grab the "multiple-access packet channel" continues inserting flags and asserting PHOLD until PREQ is asserted, by itself or another module. Once PREQ is again asserted, TDM/packet interface **310** drops PHOLD only when the insertion of an flag is finished. At this point the next packet application module then has access to the "multiple-access packet channel."

Within this general method, different approaches may be taken to offset the arbitration fairness. In general, each time a packet application module gains transmission access to the "multiple-access packet channel," it may send any prescribed number of packets. The access method may be designed to limit this number to one, or it may allow the application to empty its packet transmit buffer. If the hardware imposes no limit on the size or number of packets sent during one access period, the application software is then able to implement rules for sending varying amounts of packet traffic across the bus. There is no reason why those rules must be applied the same for every packet application module, and in fact could be different for each port.

For example, the packet application module may send as many packets as can be transmitted within a fixed amount of time. Another possibility is that the amount of packet data transmitted may be a function of the number of packets queued or the time they have been queued. The size of the packets, always known to the software, may also be a factor in determining when to terminate the access period.

The only hardware function required to support such strategies is the combination of the PREQ signal and PHOLD signal. Once the active packet application module is about to fulfill its prescribed transmission requirement, the corresponding packet interface processor either informs the respective TDM/packet interface via a control line (not shown) or the TDM/packet interface continues transmitting until a corresponding BUFFER EMPTY signal (not shown) is received by the TDM/packet interface. Whatever the signal, the TDM/packet interface then stops asserting PREQ to allow another packet application module to gain access to the TDM bus.

As noted above, the above description assumed that the packet/TDM interface was incorporated in a single ASIC bus interface chip. This is feasible if bus speeds and capacities are modest, say 10–20 Mbps maximum throughput, and only one packet channel is required. As a result, the use of an ASIC to implement a bus interface chip to integrate these functions should result in minimal additional cost (in quantity). Further, adding support for a second packet channel may be a similar incremental cost. However, boosting the TDM bus capacity to T3 rates or higher will pose the greatest potential cost increase due to higher bus clock rates and the number of 64K channels. At this level, an ASIC having a much larger gate-count may be needed to provide a large number of timeslot registers, increased buffering, and higher speed DMA channels.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope.

For example, although the invention is illustrated herein as being implemented with functional building blocks, e.g., a packet interface processor, etc., the functions of any one or

more of those building blocks can be carded out using one or more appropriate integrated circuits.

In addition, although illustrated in the context of a T1 network facility, the inventive concept applies to other network facilities as well, e.g., fractional T1, digital data service (DDS), T3, etc. Further, more than one "multiple-access packet channel," can exist. For example, a first plurality of packet application modules may be assigned to a first group of time-slots, e.g., time-slots 1–6, for transmitting packet data, while a second plurality of packet application modules is assigned to a second group of time-slots, e.g., time-slots 7–12, for transmitting packet data. Also, because the bandwidth of a TDM bus may be divided into many separate logical channels, data with different formats and access methods, such as isochronous and packet data, may be combined in the system. Mother variation is to use the time-slots to control contention access, as opposed to the "bit-time slots," described above.

It should also be noted that the inventive concept is applicable to Asynchronous Transfer Mode (ATM) transmission. In particular, ATM cells are handled in a similar manner, although not on the same "multiple-access packet channel" carrying bit-oriented protocols. In the case of ATM cells, the octets which form the cells need to be aligned within DS0 channels. This places an additional constraint on the packet/TDM interface to recognize those boundaries and transmit within them. The "bit time-slots" may still be used in the same manner as describe above for arbitration however. Another property of ATM cells is that they are not delimited by flags. Idle time between cells transporting user data must be filled with null cells. Responsibility for filling voids in the cell stream may be assigned to the packet application modules to perform in a fashion similar to adding flag fills for HDLC protocols described earlier. Alternatively, this could be the responsibility of the NAM on the outbound trunk, especially if the NAM is required to buffer cells in order to map them onto the network link.

What is claimed:

1. Data communications apparatus comprising:

a time division multiplexed bus having a bandwidth, where a portion of the bandwidth is allotted to packet data;

a plurality of packet data sources coupled to the time-division multiplexed bus that share the allotted bandwidth for transmitting packet data; and

a distributed packet manager within each of said packet data sources configured to allocate access to the allotted bandwidth among said packet data sources.

2. The apparatus of claim 1 including a packet arbitration bus comprising a packet request signal and a packet hold signal.

3. The apparatus of claim 2 wherein each packet data source comprises:

interface circuitry that inserts packets to the allocated bandwidth of the time-division multiplexed bus and is coupled to the packet arbitration bus; and

a packet data processor for providing the packets from a packet endpoint to the interface circuitry.

4. Data communications apparatus comprising:

a time-division multiplexed bus having a bandwidth, where a portion of the bandwidth is allocated to packet data;

a plurality of packet data sources coupled to the time-division multiplexed bus that share the allocated bandwidth for transmitting packet data;

a packet arbitration bus comprising a packet request signal and a packet hold signal;

interface circuitry coupled to the packet arbitration bus, said interface circuitry inserting packets to the allocated bandwidth of the time-division multiplexed bus, and performing a counting function by counting time-slots of the allocated bandwidth so long as the packet request signal is not asserted; and

a packet data processor for providing the packets from a packet endpoint to the interface circuitry.

5. The apparatus of claim 4 wherein the time-slots are bit time-slots.

6. The apparatus of claim 4 wherein the interface circuitry inserts the packets into the allocated bandwidth when a value of the counter is equal to a predetermined identification number of the respective packet data source and the packet hold signal is not asserted.

7. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth;

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data; and

a distributed packet manager within each of said packet data sources configured to allocate access to the second portion of the predefined bandwidth among said packet data sources.

8. The apparatus of claim 7 further including a network access manager coupled to the time-division-multiplexed bus for communicating the synchronous data and the packet data to at least one network facility.

9. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth; and

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data, the second portion of the predefined bandwidth being shared in such a way that only one of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time.

10. The apparatus of claim 7 wherein each one of the plurality of packet data sources includes interface circuitry to the time-division multiplexed bus for synchronizing packet data to the time-division multiplexed bus.

11. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth;

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet

data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data, wherein each one of the plurality of packet data sources includes interface circuitry to the time-division multiplexed bus for synchronizing packet data to the time-division multiplexed bus, and the interface circuitry includes a counter for counting time-slots representing the second portion of the predefined bandwidth.

12. The apparatus of claim 11 wherein the time-slots are bit time-slots.

13. The apparatus of claim 11 wherein the interface circuitry inserts packets into the second portion of the predefined bandwidth when a value of the counter equals a predetermined identification number of a respective packet data source and a hold signal is not being asserted by the interface circuitry of the remaining packet data sources.

14. The apparatus of claim 11 wherein the counter is inhibited from counting when a packet request signal is asserted by interface circuitry from any packet data source.

15. A method for use in a data communications apparatus for transmitting packet data on a time-division multiplexed bus, the method comprising the steps of:

coupling a plurality of packet data sources to the time-division multiplexed bus;

allocating a portion of the bandwidth of the time-division multiplexed bus to the plurality of packet data sources in such a way that the allocated portion is shared among the plurality of packet data sources;

transmitting packet data from the plurality of packet data sources on the allocated portion of the bandwidth; and

controlling access by said packet data sources to the allocated portion of the bandwidth via a distributed packet manager within each of said packet data sources.

16. A method for use in a data communications apparatus for transmitting packet data on a time-division multiplexed bus, the method comprising the steps of:

coupling a plurality of packet data sources to the time-division multiplexed bus;

allocating a portion of the bandwidth of the time-division multiplexed bus to the plurality of packet data sources in such a way that the allocated portion is shared among the plurality of packet data sources;

assigning to each one of the plurality of packet data sources an identification number;

counting, in each one of the plurality of packet data sources, a sequence of time-slots representing the allocated portion of the bandwidth; and

transmitting packet data from one of the plurality of packet data sources on the allocated portion of the bandwidth only when the value of the count matches the respective identification number assigned to that packet data source.

17. The method of claim 16, wherein said step of counting a sequence of time-slots representing the allocated portion of the bandwidth is enabled only when none of the plurality of packet data sources assert a packet request signal.

18. The method of claim 16, wherein said step of transmitting packet data from one of the plurality of packet data sources is enabled only if a packet hold signal is not asserted by any other one of the plurality of packet data sources.

19. The method of claim 16, wherein said step of counting a sequence of time-slots representing the allocated portion of the bandwidth further comprises counting bit time-slots.

20. A method for transmitting packet data on a time-division multiplexed bus in data communications equipment, the method comprising the steps of:

allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel;

coupling a plurality of packet data sources to the time-division multiplexed bus;

controlling the access by said packet data sources to the allocated portion of the bandwidth via a distributed packet manager within each of said packet data sources;

transmitting packet data from the one of the plurality of packet data sources having access to the multiple-access packet channel.

21. A method for transmitting packet data on a time-division multiplexed bus in data communications equipment, the method comprising the steps of:

allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel;

coupling a plurality of packet data sources to the time-division multiplexed bus;

assigning a unique identification number to each one of the plurality of packet data sources;

counting, in each one of the plurality of packet data sources, a sequence of time-slots representing the multiple-access packet channel;

granting access to the multiple-access packet channel to that one of the plurality of packet data sources that requests access when the value of the count matches the respective identification number of that packet data source; and

transmitting packet data from the one of the plurality of packet data sources having access to the multiple-access packet channel.

22. The method of claim 21 wherein the counting step is enabled only when none of the plurality of packet data sources assert a packet request signal.

23. The method of claim 21 wherein the granting step further includes the step of asserting a packet request signal by the packet data source granted access.

24. The method of claim 21 wherein the counting step counts a sequence of bit time-slots.

25. A method for transmitting packet data on a time-division multiplexed bus for use in data communications equipment, the method comprising the steps of:

allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel;

coupling a plurality of packet data sources to the time-division multiplexed bus;

arbitrating between the plurality of packet data sources to grant access to the multiple-access packet channel to one of the plurality of packet data sources at a time; and

transmitting packet data from the one of the plurality of packet data sources having access in the arbitrating step only if a packet hold signal is not asserted by another one of the plurality of packet data sources.

26. The method of claim 20 further comprising the step of coupling a network access module to the time-division multiplexed bus for receiving the packet data for transmission over a network facility.

27. A data communications apparatus, comprising;

a time-division multiplexed bus with a bandwidth which is split into at least two portions, one of the portions being allocated for packet data;

a plurality of packet data sources coupled to said time-division multiplexed bus, the packet data sources transmitting packet data on said portion allocated for packet data; and

means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data among the plurality of packet data sources.

28. The apparatus of claim **27**, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises a packet arbitration bus having a packet request signal and a packet hold signal, the arbitration bus being coupled to each of the packet data sources, and the packet data sources including means for generating the packet request signal and the packet hold signal.

29. The apparatus of claim **28**, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises a means within each packet data source for counting the time-slots of the portion of the time-division multiplexed bus.

30. The apparatus of claim **29**, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises the communication of packet data by one of the packet data sources when the packet hold signal is not asserted and the value of said counting means is equal to a predetermined identification number assigned to said packet data source.

31. The apparatus of claim **29**, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises means for generating the packet request signal by a packet data source wishing to gain access to the time-division multiplexed bus when the value of said counting means is equal to a predetermined identification number assigned to said packet data source, said counting means being stopped by said packet request signal.

32. The apparatus of claim **29**, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises means for releasing said packet request signal and for asserting said packet hold signal by a packet data source while said packet data source is transmitting packet data.

* * * * *

<u>Exhibit 2</u>

United States Patent [19]

King

[11] **Patent Number: 4,937,819**

[45] **Date of Patent: Jun. 26, 1990**

[54] **TIME ORTHOGONAL MULTIPLE VIRTUAL DCE FOR USE IN ANALOG AND DIGITAL NETWORKS**

[75] Inventor: **Joseph B. King,** St. Petersburg, Fla.

[73] Assignee: **A.T. & T. Paradyne,** Largo, Fla.

[21] Appl. No.: **249,450**

[22] Filed: **Sep. 26, 1988**

[51] **Int. Cl.**[5] **H04J 3/16**

[52] **U.S. Cl.** **370/95.3;** 370/95.1; 370/85.7; 370/104.1

[58] **Field of Search** 370/96, 90, 85, 86, 370/95, 79, 82, 94, 104, 95.1, 95.2, 95.3, 85.7, 104.1, 94.1; 375/12, 13, 14; 340/825.5, 825.51

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,398,289	8/1983	Schoute	370/95
4,489,416	12/1984	Stuart	375/13
4,606,023	8/1986	Dragoo	370/104
4,644,534	2/1987	Sperlich	370/95
4,653,049	3/1987	Shinmyo	370/95
4,669,090	5/1987	Betts et al.	375/13
4,694,453	9/1987	Kobayashi et al.	370/85
4,726,017	2/1988	Krum et al.	370/85
4,742,512	5/1988	Akashi et al.	370/96
4,748,621	5/1988	Ballance et al.	370/95
4,757,502	7/1988	Meuriche et al.	370/104
4,759,016	7/1988	Otsuka	370/95
4,797,878	1/1989	Armstrong	370/96
4,800,560	1/1989	Aoki et al.	370/104
4,807,259	2/1989	Yamanaka et al.	370/85

OTHER PUBLICATIONS

Mischa Schwartz, "Communication Systems & Techniques", 1966, p. 173.

A. Bruce Carlson, "Communication Systems: An introduction to Signals & Noise in Electrical Communication", 1968, p. 377.

James Martin, "Satellite Communications", 1978, pp. 276–278.

Primary Examiner—Douglas W. Olms
Assistant Examiner—Alpus H. Hsu
Attorney, Agent, or Firm—Kane, Dalsimer, Sullivan, Kurucz, Levy, Eisele and Richard

[57] **ABSTRACT**

Apparatus and method for time division multiple access in a multidrop system with multiple host applications Employing half-duplex polled protocols is disclosed. Ranging with respect to time is used so as to reduce guard time between successive transmissions thereby increasing system efficiency. Host applications can request extra time slots for long messages via a request bit within the message format.

15 Claims, 9 Drawing Sheets

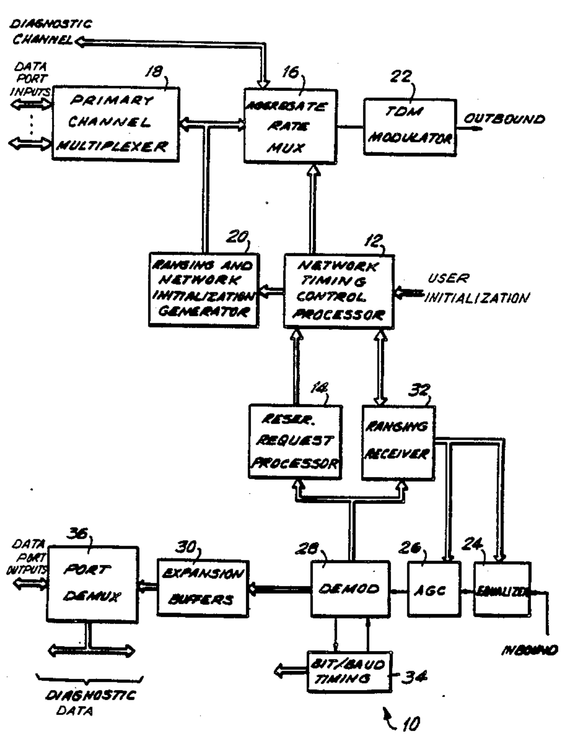
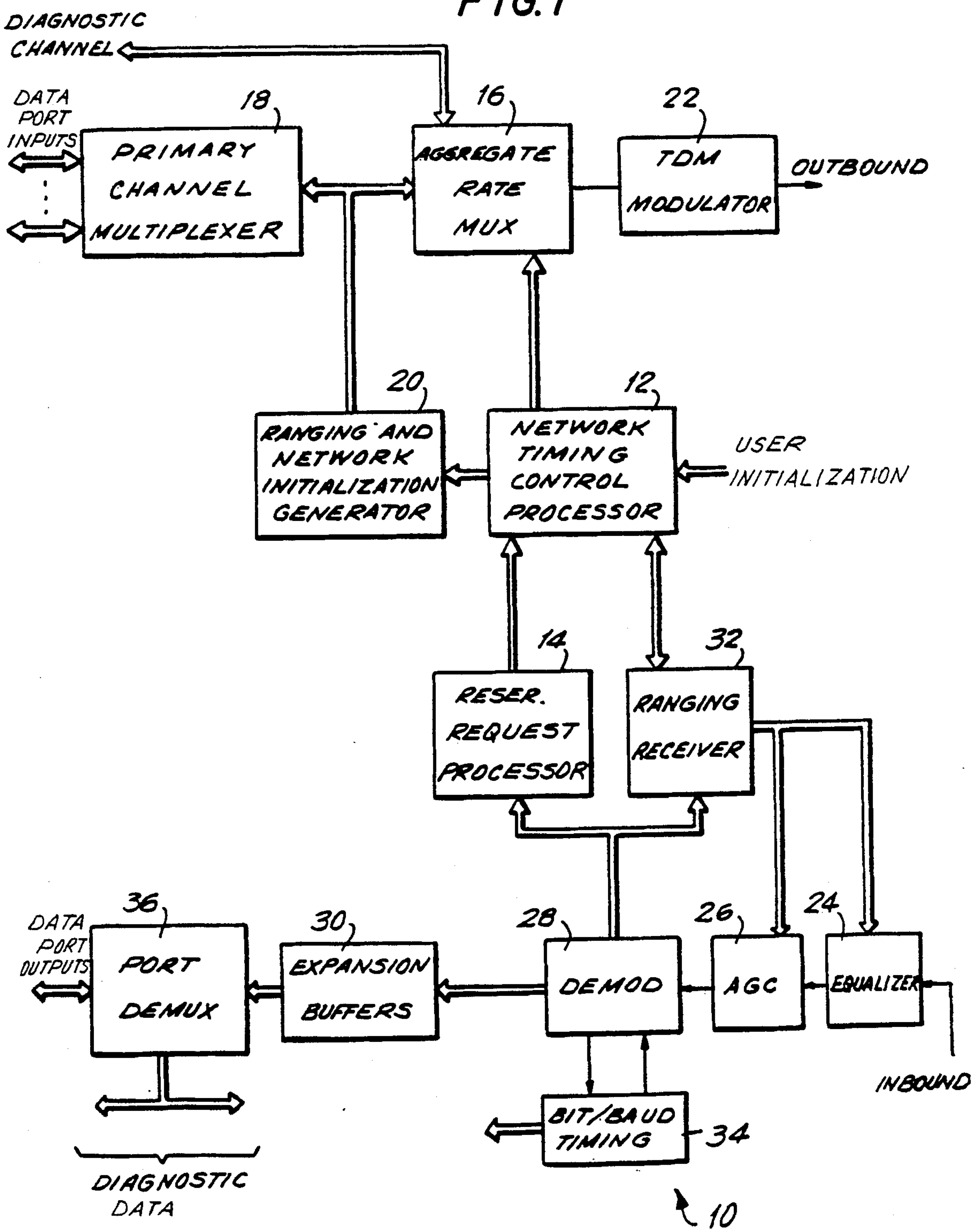


FIG. 1



DIAGNOSTIC CHANNEL
DATA PORT INPUTS
18
PRIMARY CHANNEL MULTIPLEXER
16
AGGREGATE RATE MUX
22
TDM MODULATOR
OUTBOUND
20
RANGING AND NETWORK INITIALIZATION GENERATOR
12
NETWORK TIMING CONTROL PROCESSOR
USER INITIALIZATION
14
RESER. REQUEST PROCESSOR
32
RANGING RECEIVER
DATA PORT OUTPUTS
36
PORT DEMUX
30
EXPANSION BUFFERS
28
DEMOD
26
AGC
24
EQUALIZER
INBOUND
BIT/BAUD TIMING
34
DIAGNOSTIC DATA
10

FIG. 2

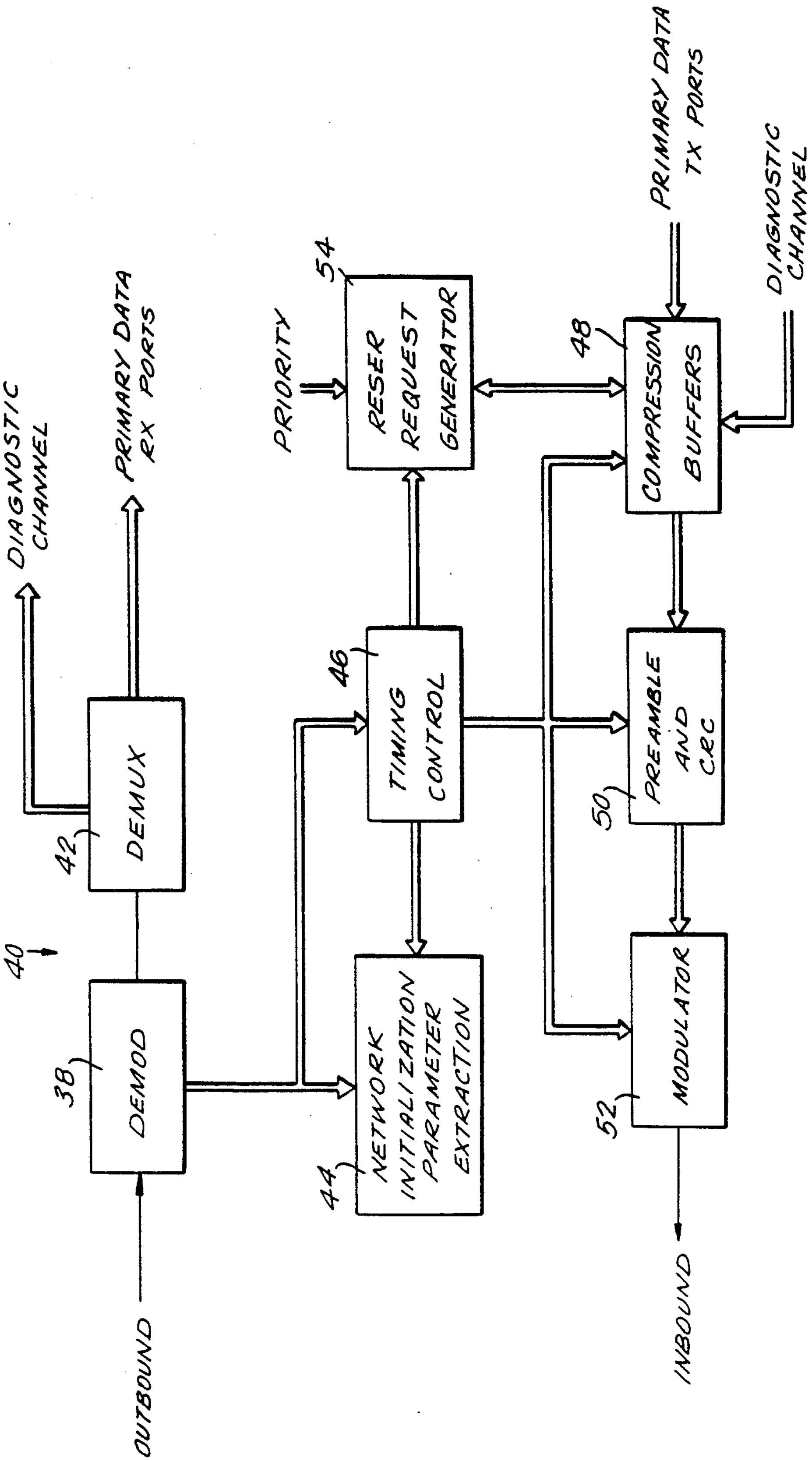
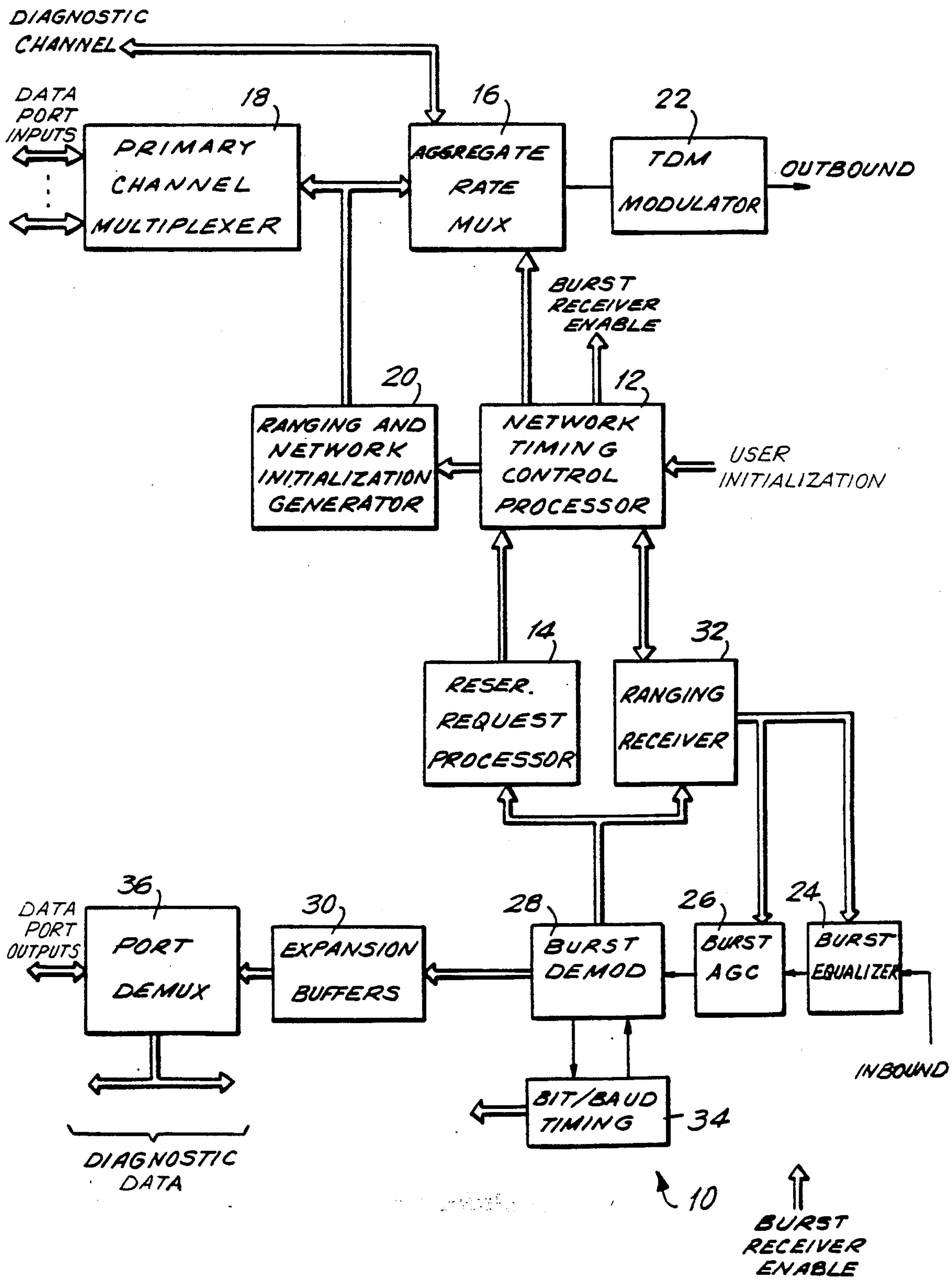
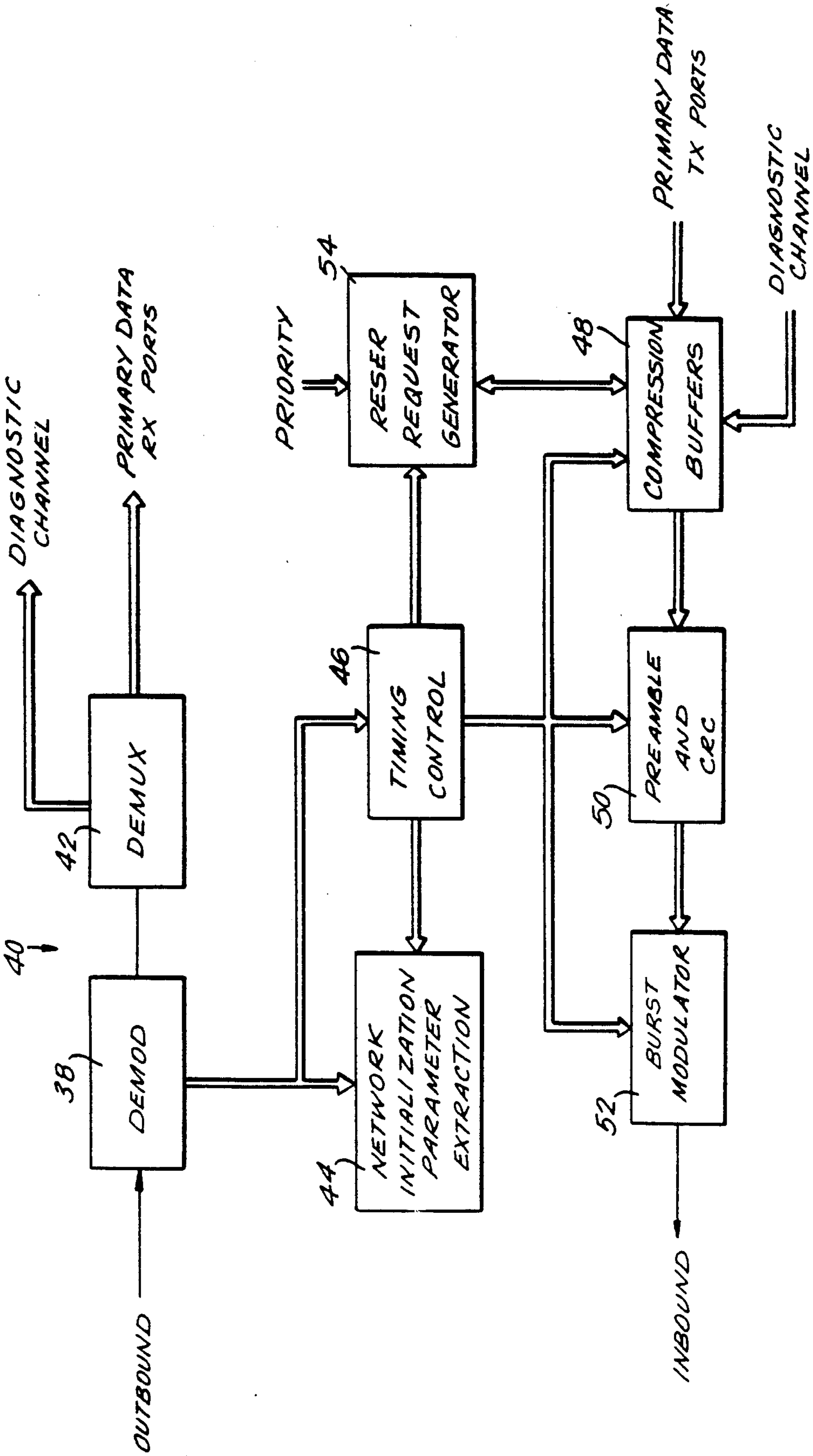

40
OUTBOUND
DEMOD
38
DEMUX
42
DIAGNOSTIC CHANNEL
PRIMARY DATA RX PORTS
NETWORK INITIALIZATION PARAMETER EXTRACTION
44
TIMING CONTROL
46
RESER REQUEST GENERATOR
54
PRIORITY
COMPRESSION BUFFERS
48
PRIMARY DATA TX PORTS
DIAGNOSTIC CHANNEL
PREAMBLE AND CRC
50
MODULATOR
52
INBOUND

FIG. 3



DIAGNOSTIC CHANNEL
DATA PORT INPUTS
18
PRIMARY CHANNEL MULTIPLEXER
16
AGGREGATE RATE MUX
22
TDM MODULATOR
OUTBOUND
BURST RECEIVER ENABLE
20
RANGING AND NETWORK INITIALIZATION GENERATOR
12
NETWORK TIMING CONTROL PROCESSOR
USER INITIALIZATION
14
RESER. REQUEST PROCESSOR
32
RANGING RECEIVER
36
DATA PORT OUTPUTS
PORT DEMUX
30
EXPANSION BUFFERS
28
BURST DEMOD
26
BURST AGC
24
BURST EQUALIZER
INBOUND
BIT/BAUD TIMING
34
DIAGNOSTIC DATA
10
BURST RECEIVER ENABLE

FIG. 4


OUTBOUND
DEMOD
38
40
DEMUX
42
DIAGNOSTIC CHANNEL
PRIMARY DATA RX PORTS
NETWORK INITIALIZATION PARAMETER EXTRACTION
44
TIMING CONTROL
46
RESER REQUEST GENERATOR
54
PRIORITY
COMPRESSION BUFFERS
48
PRIMARY DATA TX PORTS
DIAGNOSTIC CHANNEL
PREAMBLE AND CRC
50
BURST MODULATOR
52
INBOUND

Case 2:05-cv-00443-TJW-CE Document 131-3 Filed 01/18/2007 Page 7 of 15

FIG. 5

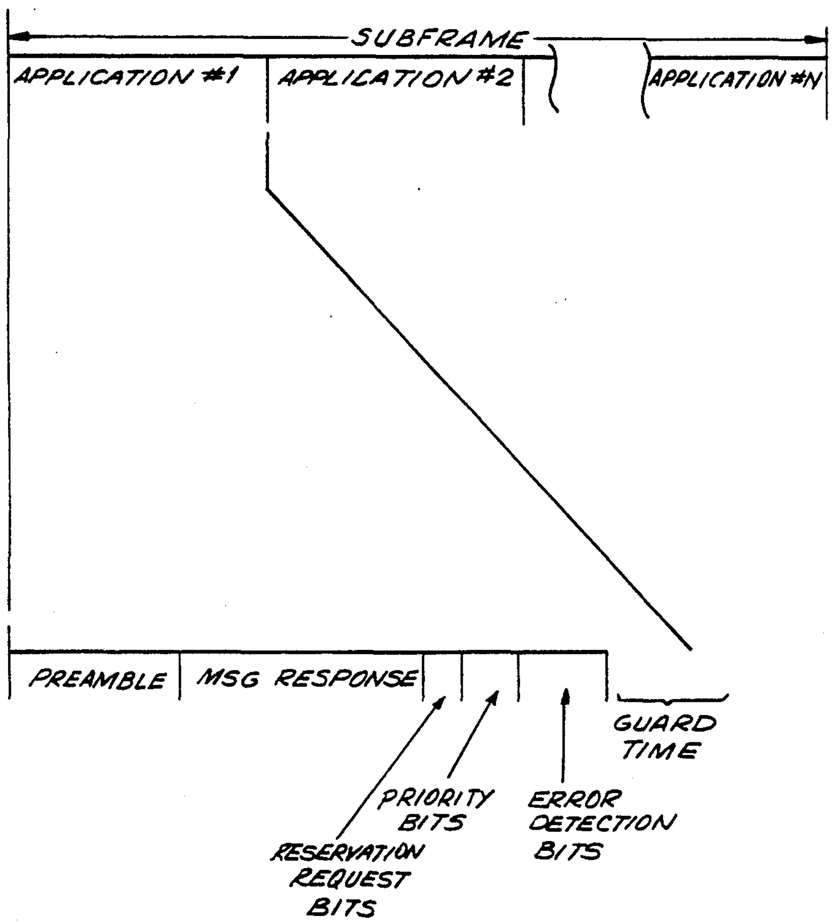


FIG. 6

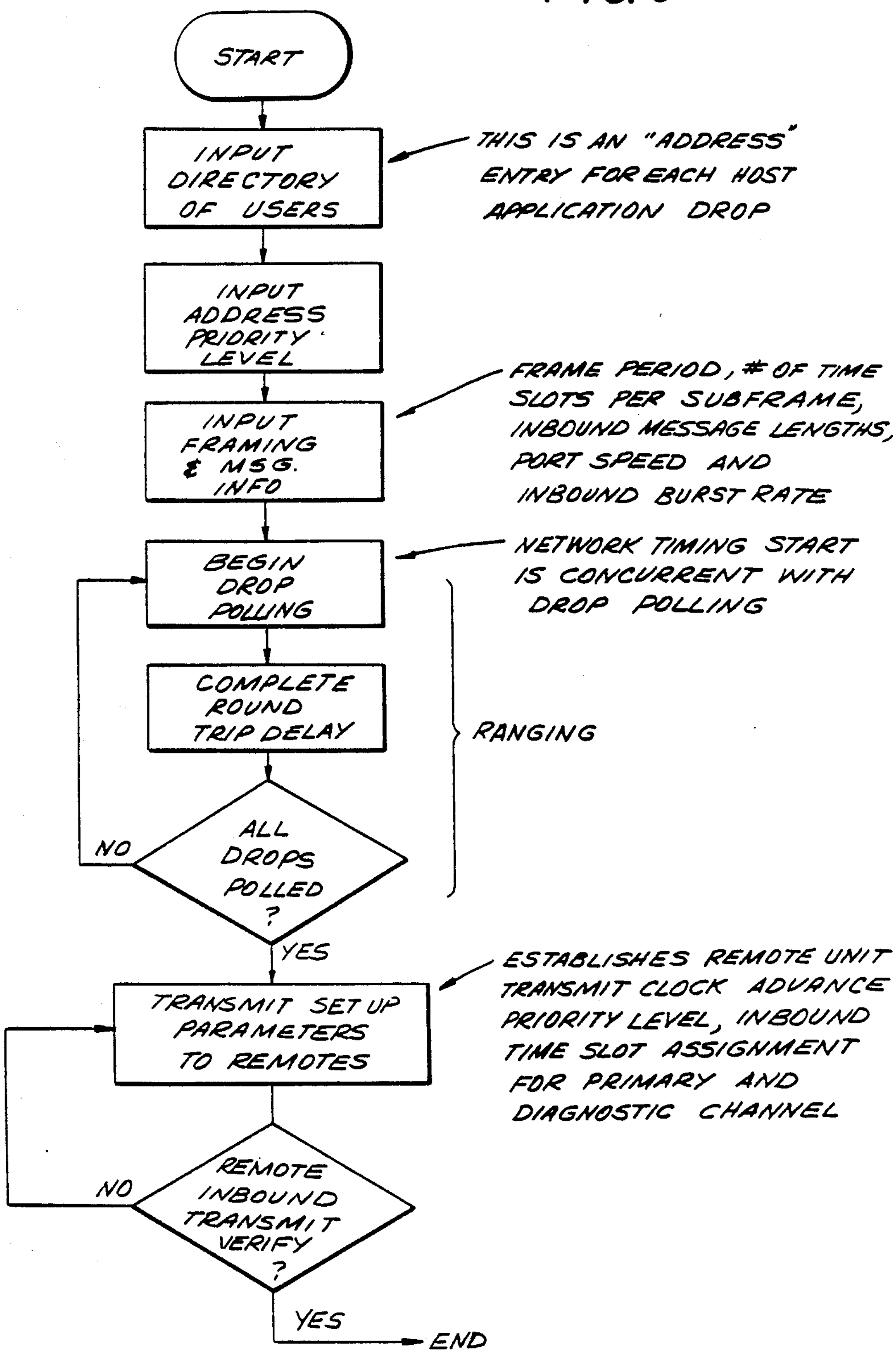

START
INPUT DIRECTORY OF USERS
THIS IS AN "ADDRESS" ENTRY FOR EACH HOST APPLICATION DROP
INPUT ADDRESS PRIORITY LEVEL
INPUT FRAMING & MSG. INFO
FRAME PERIOD, # OF TIME SLOTS PER SUBFRAME, INBOUND MESSAGE LENGTHS, PORT SPEED AND INBOUND BURST RATE
BEGIN DROP POLLING
NETWORK TIMING START IS CONCURRENT WITH DROP POLLING
COMPLETE ROUND TRIP DELAY
RANGING
ALL DROPS POLLED ?
NO
YES
TRANSMIT SET UP PARAMETERS TO REMOTES
ESTABLISHES REMOTE UNIT TRANSMIT CLOCK ADVANCE PRIORITY LEVEL, INBOUND TIME SLOT ASSIGNMENT FOR PRIMARY AND DIAGNOSTIC CHANNEL
REMOTE INBOUND TRANSMIT VERIFY ?
NO
YES
END

FIG. 7

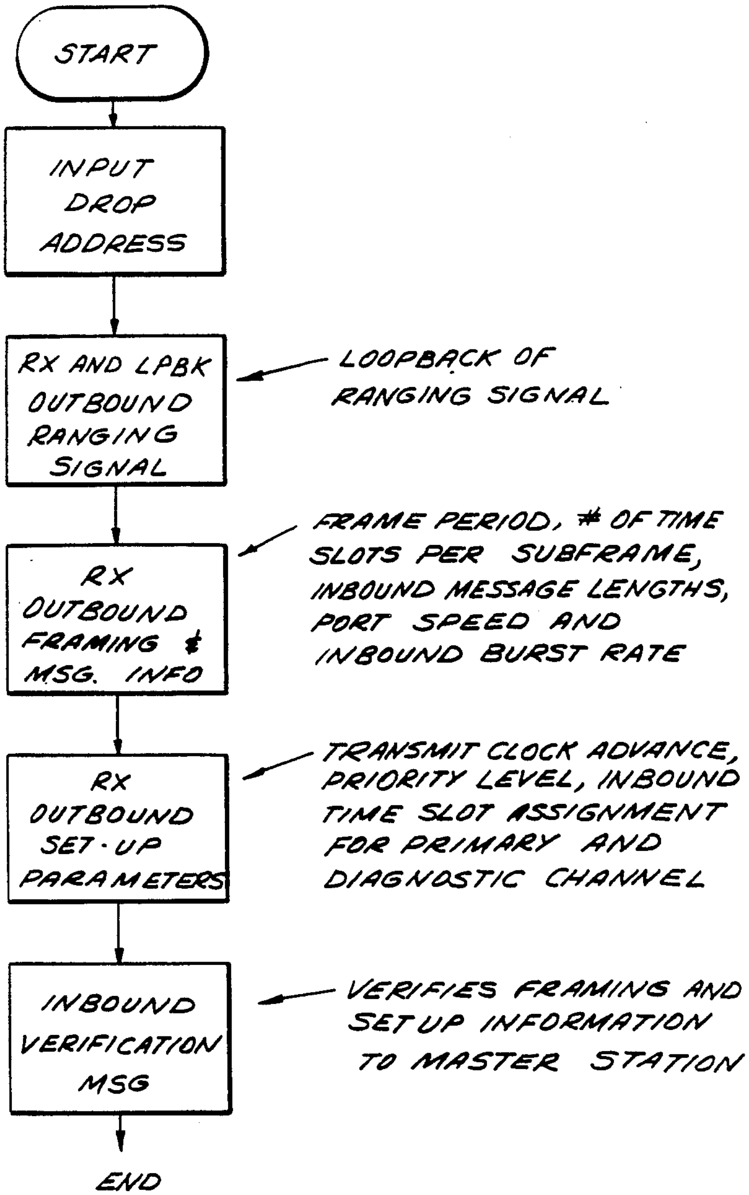

START
INPUT DROP ADDRESS
RX AND LPBK OUTBOUND RANGING SIGNAL
LOOPBACK OF RANGING SIGNAL
RX OUTBOUND FRAMING & MSG. INFO
FRAME PERIOD, # OF TIME SLOTS PER SUBFRAME, INBOUND MESSAGE LENGTHS, PORT SPEED AND INBOUND BURST RATE
RX OUTBOUND SET-UP PARAMETERS
TRANSMIT CLOCK ADVANCE, PRIORITY LEVEL, INBOUND TIME SLOT ASSIGNMENT FOR PRIMARY AND DIAGNOSTIC CHANNEL
INBOUND VERIFICATION MSG
VERIFIES FRAMING AND SET UP INFORMATION TO MASTER STATION
END

FIG. 8

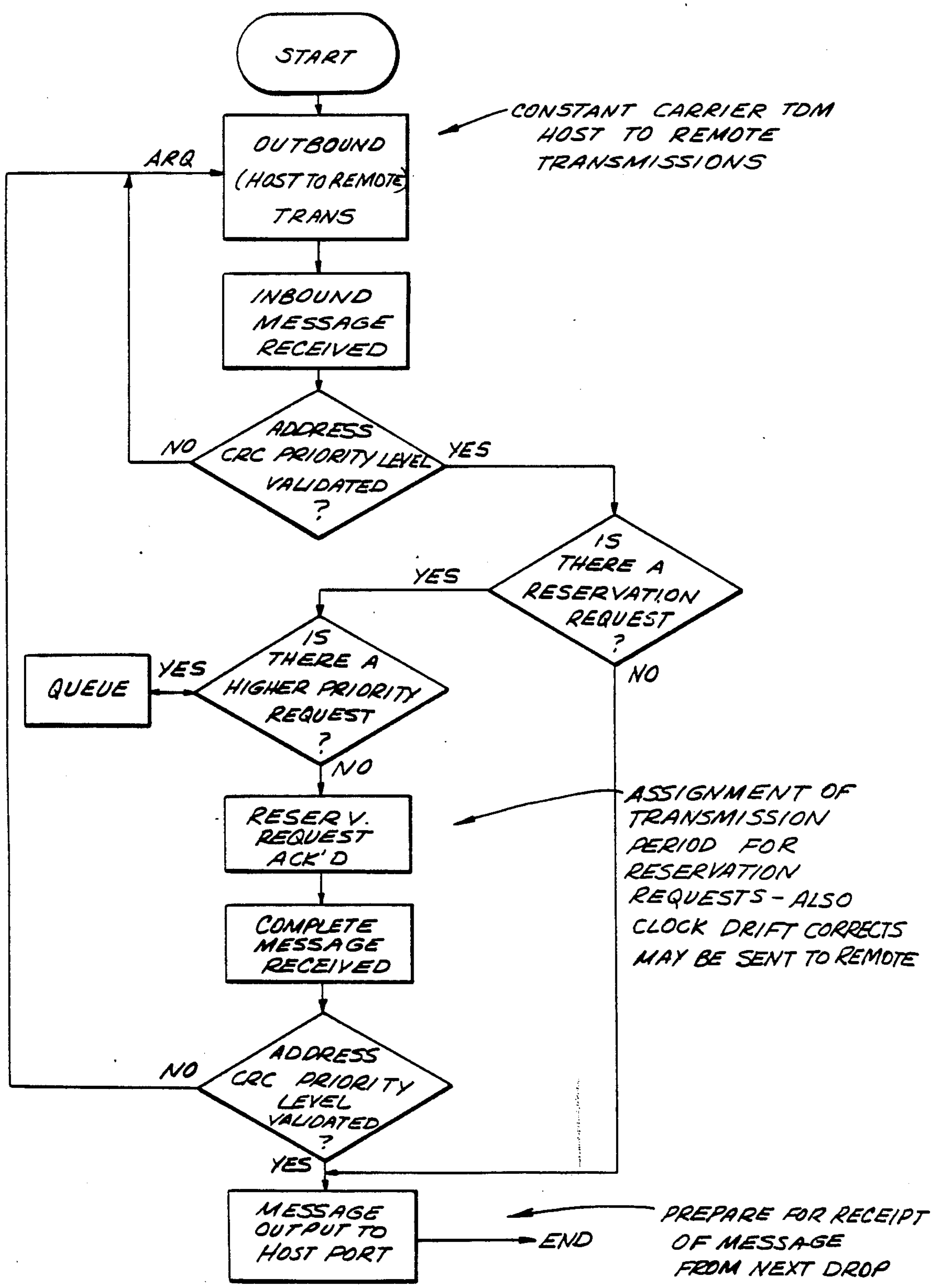
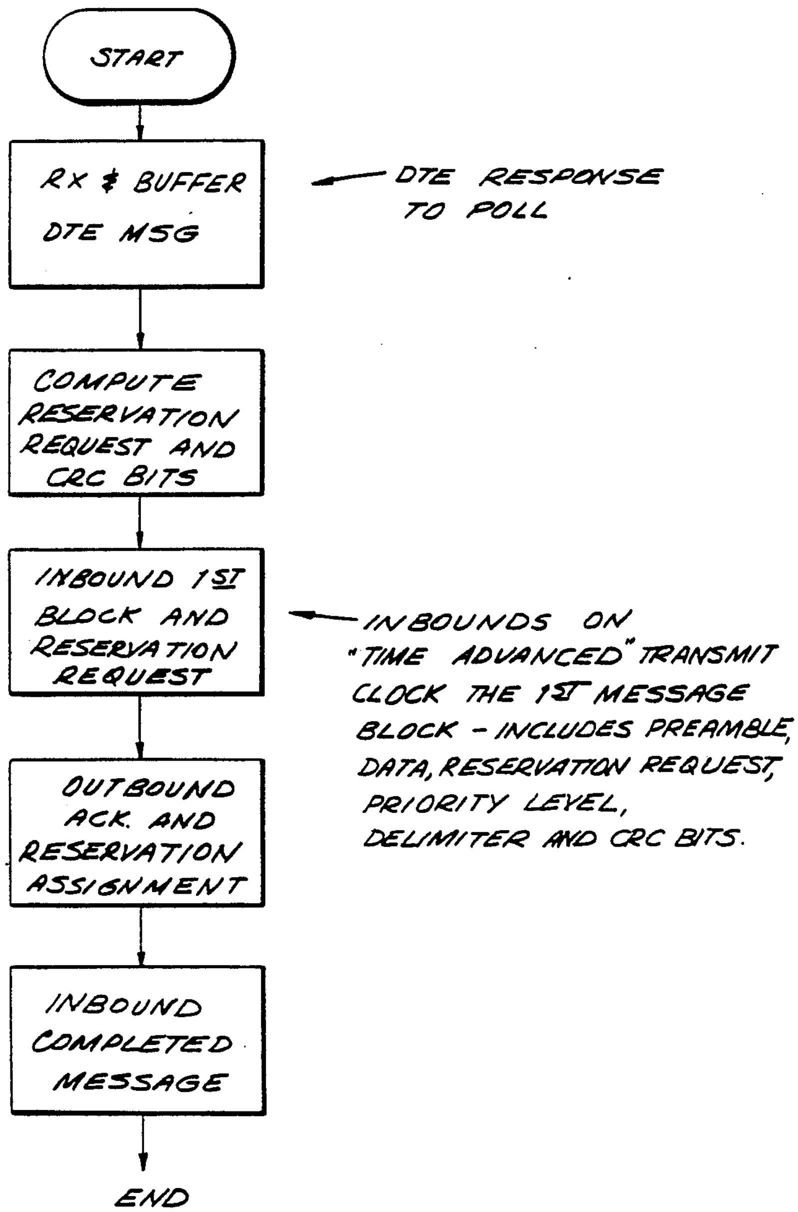

START
OUTBOUND (HOST TO REMOTE) TRANS
CONSTANT CARRIER TDM HOST TO REMOTE TRANSMISSIONS
ARQ
INBOUND MESSAGE RECEIVED
ADDRESS CRC PRIORITY LEVEL VALIDATED ?
NO
YES
IS THERE A RESERVATION REQUEST ?
YES
NO
IS THERE A HIGHER PRIORITY REQUEST ?
YES
QUEUE
NO
RESERV. REQUEST ACK'D
ASSIGNMENT OF TRANSMISSION PERIOD FOR RESERVATION REQUESTS - ALSO CLOCK DRIFT CORRECTS MAY BE SENT TO REMOTE
COMPLETE MESSAGE RECEIVED
ADDRESS CRC PRIORITY LEVEL VALIDATED ?
NO
YES
MESSAGE OUTPUT TO HOST PORT
END
PREPARE FOR RECEIPT OF MESSAGE FROM NEXT DROP

FIG. 9


START
RX & BUFFER DTE MSG
DTE RESPONSE TO POLL
COMPUTE RESERVATION REQUEST AND CRC BITS
INBOUND 1ST BLOCK AND RESERVATION REQUEST
INBOUNDS ON "TIME ADVANCED" TRANSMIT CLOCK THE 1ST MESSAGE BLOCK - INCLUDES PREAMBLE, DATA, RESERVATION REQUEST, PRIORITY LEVEL, DELIMITER AND CRC BITS.
OUTBOUND ACK. AND RESERVATION ASSIGNMENT
INBOUND COMPLETED MESSAGE
END

TIME ORTHOGONAL MULTIPLE VIRTUAL DCE FOR USE IN ANALOG AND DIGITAL NETWORKS

BACKGROUND OF INVENTION

1. Field of Invention

This invention relates to an apparatus and method for a master unit in a multidrop network to communicate to and from a plurality of remote units, using a plurality of host applications using half duplex polled protocols, through the use of time division multiple access techniques.

2. Scope of the Prior Art

In the prior art, in order to run multiple host applications to multiple modems in a multidrop network, it is common to use a single network channel for each application, thereby effectively resulting in a number of networks rather than a single network. Further, such an arrangement is clearly an inefficient use of leased lines and other equipment.

A common solution to this deficiency of the prior art is to use a single line with frequency division multiplexing. That is, a number of orthogonal carrier frequencies, one for each application, are transmitted over a single line to a plurality of remote units in a multidrop network. However, with such apparatus, the non-linearities of the communications line (most frequently, a telephone line), interfere with the co-existence of multiple carrier frequencies. This interference includes intermodulation, cross-modulation and spillover between and among channels. Furthermore, a strong signal on one carrier frequency could suppress a weak signal on another carrier frequency.

Due to this interference, time-consuming engineering adjustment is required to install and maintain such a system. Such interference increases with an increasing number of co-existing carrier frequencies, thereby limiting the number of carrier frequencies which could be practically carried on a single line. For practical applications, no more than three carrier frequencies can be carried simultaneously on a telephone line.

OBJECTS AND SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a method and apparatus for allowing a single multidrop network to run multiple applications to multiple remote units.

It is therefore a further object of this invention to provide such a method and apparatus without a fundamental limitation on the number of applications which can be implemented.

It is therefore a further object of this invention to reduce the amount of engineering adjustment needed to install and maintain such a method and apparatus.

The present method and apparatus permits multiple multidrop networks (such as Dataphone Digital Service for digital applications or conventional telephone company lines for analog applications), each serving a distinct half-duplex host polled application, to be replaced by a single multidrop network serving each of said host applications.

The basic features of this method and apparatus are time division multiplexed outbound transmissions from the master to the remote units for data and control; time division multiple access transmissions inbound from the remote units to the master unit; master to remote ranging with respect to transmission time; and priority as-

signed reservation request for long poll responses. A channel rate exceeding the aggregate port rate is required in order to transmit effectively all of the information from the remote units and allow for control format messages. All remote units (or "drops") receive messages outbound from the control unit and respond in a unique time period assigned to each host application. Contention between applications is thereby avoided due to the fact that each application is assigned such a unique time period. By ranging or measuring the round-trip transmission or delay time between the master unit and each remote unit, and storing these times in a table so as to accurately synchronize the transmissions in a time division multiple access mode, the "guard time" separating inbound transmissions from interfering with each other can be minimized thereby increasing system efficiency.

In order to accommodate longer message lengths from a remote unit to the master unit, a remote unit can append a request for additional time onto its message to the master unit. The master unit will then compare the priority of the requesting remote unit to the priority of subsequent units and make a decision as to whether to allow the requesting remote unit to use the time division multiple access slots of subsequent units.

By the use of the foregoing, a user can install several host applications employing half duplex polling on a single multidrop network, without a fundamental limit on the number of applications and without the need for extensive engineering adjustment during the installation and maintenance of the system. This allows an end user to have fewer modems or data service units/channel service units (DSU/CSU) on the customer premises.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. I shows a block diagram of the master unit in the digital application of this invention.

FIG. II shows a block diagram of the remote unit in the digital application of this invention.

FIG. III shows a block diagram of the master unit in the analog application of this invention.

FIG. IV shows a block diagram of the remote unit in the analog application of this invention.

FIG. V shows a schematic of a subframe format.

FIG. VI shows a flow diagram of the initialization of the master unit.

FIG. VII shows a flow diagram of the initialization of the remote unit.

FIG. VIII shows a flow diagram of the normal operation of the master unit.

FIG. IX shows a flow diagram of the normal operation of the remote unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail wherein like numerals refer to like elements throughout the several views, master unit **10** for digital applications is shown FIG. I. Master unit **10** includes a network timing and control processor **12**. Network timing and control processor **12** uses firmware or software to implement clock drift reset functions, guard time predict functions, burst receiver control functions, reservation assignment functions, cyclic redundancy check (crc) "checksum" calculations, arq functions, remote transmit control functions and user library update functions such as activity rate and frame parameters. Additionally, network timing

and control processor **12** stores user-input initialization parameters including network clock framing periods, slot and subframe assignments, inbound and outbound burst length for each "drop" or remote unit, priority assignments, drop addressing, and port speed assignments.

Reservation request processor **14** allows a drop or remote unit to request more than a single time slot for longer messages. Reservation request processor **14** communicates such a granted request to the network timing and control processor **12**.

The aggregate rate multiplexing module **16**, in response to commands from the network timing and control processor **12**, sets up the timing and bit interleaving of the various application inputs from the various input ports of the primary channel multiplexer **18** and of the overhead and control bits required for outbound control of the remote units from the ranging and network initialization generator **20**. The output of the aggregate rate multiplexer **16** is input to the time division multiplexed modulator **22** which transmits the data to the various drops or remote units (see FIG. II). The time division multiplexed modulator **22** is typically a baseband modulator for digital applications.

The master unit **10** also provides, in addition to primary traffic flow over the channel outbound to remote units, a diagnostic channel which can be inband, and any control information necessary to update clock drifts, perform new ranging, etc.

The input in the form of noncontending packets or bursts of information from the various drops or remote units is received via a single data channel by equalizer **24**. The input stream has its gain automatically adjusted **26** and is demodulated by demodulator **28**.

Demodulator **28** provides digital data to the expansion buffers **30**, the ranging receiver **32**, the reservation request processor **14** and the bit/baud timing processor **34**.

The expansion buffers **30** output digital data to the data port outputs of the various applications and a diagnostic channel via the port demultiplexer **36**.

The ranging receiver **32** receives data from the demodulator **28** during an initial training period (to be described later) so as to store round trip transmission times to each remote unit. This allows an optimization in synchronization of the time division multiple access process, thereby reducing "guard time" between the reception of data from the various remote units thereby increasing the total data transfer rate of the system.

Referring now to FIG. II, data outbound from the time division multiplexed modulator **22** of FIG. I is received by the demodulator **38** of remote unit **40**. The output of demodulator **38** is demultiplexed by demultiplexer **42** which, in turn, feeds the primary data receiver ports and any diagnostic or secondary channel required by the particular application. The demodulator **38** also provides bits to the network initialization parameter extraction module **44** and the timing and control block **46**. Network initialization parameter extraction module **44** and timing and control block **46** provide the user with network timing extraction information, the slot assignment in which the user is allowed to operate and any control information such as transmit inhibit, transmit enable, reservation grants and other network control provided by the master unit (see FIG. I). Additionally, the ranging calculations, that is, the master unit calculation of the time a signal takes to go from the master unit to any remote unit and vice versa, is stored

in the timing and control block **46** where it is used for time advancing the transmit clock.

The timing and control block **46** supplies control bits to compression buffers **48**. The timing and control block **46** also feeds the preamble and cyclic redundancy check ("checksum") module **50** and the modulator **52**. Additionally, the timing and control block **46** sets up the reservation request generator **54**. Reservation request generator **54** monitors the compression buffer for fields exceeding a preset parameter limit which is stored in the initialization parameter table. If a field length exceeding the parameter is sensed, then reservation request generator **54** automatically sets the reservation bits in the outgoing message. The format of the outgoing message, including reservation bits, crc bits, message traffic and preambles are described later herein.

Modulator **52** outputs messages via the communication lines to equalizer **24** of the master unit (see FIG. I).

FIG. III discloses the analog version of the master unit. FIG. I is identical to FIG. III except for the addition of the automatic gain control/equalizer tap store function which is added to ranging receiver **32** so as to provide operating parameters to the burst equalizer **24** and the burst automatic gain control **26** dependent upon the particular remote unit which is transmitting to the master unit. Furthermore, as data is transmitted in "bursts" from the remote unit in the analog mode, such elements as the demodulator, agc, and equalizer in the master unit are entitled "burst demodulators", "burst agc", and "burst equalizer" respectively in the master unit. Similarly, the analog modulator in the remote unit is entitled "burst modulator" (FIG. IV).

This is due to the fact that, in the preferred embodiment, the analog mode requires a true burst mode of operation whereas in the digital case, the burst mode requirement is eliminated due to the presence of a constant envelope baseband which includes idle codes when data is not being transmitted.

It should be noted here that the digital application, for instance, one using Dataphone Digital Service, has an inherent advantage over the analog counterpart, and is therefore a slightly preferred embodiment, in that the inbound traffic received at the master unit is a continuous transmission. That is, either information or idle codes are always being transmitted. There are no periods when the signal is not present. As a result, the number of overhead bits required in each remote transmission in the digital application is considerably reduced. This combined with the high channel to port speed ratio permits lower delay penalties. This results in a greater efficiency in the digital system as compared with the analog system.

The time division multiple access sequence is established by the user. An epoch period or frame is defined by the user. The frame is divided with respect to time into a number of subframes. The subframe is further subdivided into slots, one for each application. Therefore, an application has a preassigned time period (or slot) within a subframe to transmit from the remote unit to the master unit, with the possibility of a reservation request for longer messages.

FIG. V discloses a typical subframe. A subframe is divided into N time slots, each separated by a guard time. Each slot contains a preamble, message bits, reservation request bits, priority bits, and error detection bits. The reservation and priority bits may be replaced by address bits. For example, five bits would permit up to 32 drops. The address bits would be an identifier to

the master. The master could then monitor remote clock accuracy, monitor drop transmission events, perform ranging, etc.

Due to the number of total bits exceeding the number of message bits, the aggregate burst (in the case of analog) or transmission (in the case of digital) rate must be higher than the sum of the independent port rates.

As part of the installation of this device, both the master and remote units must be initialized.

As is disclosed in FIG. VI, the first step in the initialization of the master unit is to input the directory of users. This is an address entry for each host application drop.

The next step is to input the address priority level. This is followed by an initialization of such system parameters as frame period, number of time slots per subframe, inbound message lengths, inbound and outbound transmission rates (notice that aggregate burst rate must be higher than the sum of the independent port rates so as to accommodate individual ports along with associated overhead), priority assignments, drop addressing and, port speed assignments. This information is stored in the network timing and control processor.

The initialization phase of operation also includes a ranging calculation for each combination of remote unit (or "drop") and application. The master unit sends a message which makes a round-trip between the master unit and the individual remote unit. The delay period is stored in a library table in the network timing and control processor **12** so that the remote to master unit communication is synchronized, thereby reducing guard time required between successive transmissions and increasing the efficiency of the system.

Additionally, in the case of analog apparatus, the signals received by the master unit during the ranging calculation are used to train the automatic gain control **26** and the equalizer **24**, thereby generating an automatic gain control/equalizer tap store function.

Finally, "set-up" parameters are transmitted from the master unit to the remote units so as to establish remote unit transmit clock advances, priority level, and inbound time slot assignments for the primary and diagnostic channels. The remote unit verifies receipt to the master unit.

Initialization of the remote drops is disclosed in FIG. VII. The user inputs the address of the drop or remote unit. The remote unit returns or "loops-back" the ranging signal from the master unit. The remote unit receives the frame period, the number of time slots per subframe, inbound message lengths, port speed and inbound burst (digital) or transmission (analog) rate.

The remote unit receives set-up parameters such as clock advance, priority level and inbound time slot assignment for the primary and diagnostic framing and set-up information to the master unit.

A flow diagram of the normal operation of the master unit is shown in FIG. VIII.

The master unit sends a message to one of the remote units. An inbound message is received from one of the remote units. The address, cyclic redundancy calculation (i.e. checksum) and priority level are checked. If any of these values are invalid, the master unit retransmits to the remote unit. If these values are valid and there is no reservation request, the message is output to the appropriate application host port at the master end. This process is continually repeated for each application in each remote unit.

If the aforementioned values are valid but there is a reservation request, then the message is queued in the event that there is a higher priority request or acknowledged and completely received in the event that there is no higher priority request. After the complete message is received, its address, checksum and priority are validated. If these values are valid, the message is output to the host port. If the values are not valid, the initial step of an outbound transmission from the master to the remote is returned.

FIG. IX discloses the normal operation of a drop or remote unit. The remote unit receives and buffers a DTE poll response message. The remote unit computes the reservation request and the CRC (cyclic redundancy check or checksum) bits. The CRC bits provide error detection for both overhead and transmit port primary data bits. The remote unit transmits the first block of data, and possibly a reservation request on the inbound channel at a predetermined time in accordance with the "time advanced" (to allow for transmission time and synchronize so as to reduce guard time) transmit clock. This block of data includes preamble data, reservation request, priority level, delimiter and CRC bits.

From the foregoing, it is seen that this system includes the following features:

1. The master to remote (outbound) transmission is a constant carrier time division multiplexed bit stream in which multiple Host/FEP poll and data traffic is bit interleaved along with master to remote network timing control and diagnostic information.

2. The master unit periodically transmits a network clock reading to all remotes and performs a roundtrip delay transmission calculation ("ranging") to each remote unit. The master unit informs each remote unit of its precise round trip value.

3. The period of the master network clock transmission establishes a "frame". This frame is further segmented into subframes at the remote.

4. The remote establishes a receive clock reference (a delayed version of the Master Network Clock) and a transmit clock reference.

5. For analog applications, the remote sends a long train to the master and the master trains and stores equalization taps and automatic gain control settings unique to the drop. This is unnecessary for digital networks due to the continuous presence of traffic (either idle codes or data).

6. The master unit preassigns time slots within the subframes, one for each of the independent host applications.

7. Upon receiving a poll at the remote DTE, RTS/CTS toggles and the DTE response bits are loaded into a buffer. The remote then transmits these bits in the assigned time slot using the transmit clock reference. Therefore, contention due to inbound poll responses from other remotes is precluded. All inbound transmissions contain a preamble, poll response data bits, reservation request bits, at least one priority bit and error detection bits. In the case of analog networks, the preamble is unique to the remote and enables the master to rapidly set the equalization taps and automatic gain control.

8. All inbound transmissions are at burst rates exceeding the remote port rate.

9. The subframe time slot is sized for the dominant poll response message length for the application. For longer transmissions, the remote unit sets the reserva-

tion bits to identify the required number of additional time slots. The priority bit or bits define the remote's relative importance in reducing poll-response delays. The master unit clocks the received message bits to the expansion buffer **30** and checks the reservation and priority bits for error. If no errors are detected, the master responds to the remote with an "authorization to transmit" command and transmits a "transmit inhibit" command to all of the other remote units. Each of these outbound transmissions are error protected so that remote transmission contention is extremely unlikely. The authorized remote commences transmission on the next available time slot and continues until the message transmission has been completed. During this period the expansion buffer clocks data bits to the host.

10. The master unit can recognize whether a remote clock is drifting and so inform the remote with a fast or slow correction value. Such information can be extracted from the actual time of arrival compared with the expected time of arrival at the master unit and the preamble which identifies the transmitted remote.

11. Analysis diagnostic related information is bit interleaved onto the outbound transmission. Because of the relatively slow poll rate of the Analysis system, the inbound response may be assigned to time slot in every Nth subframe. Thus, the aforementioned goals are achieved.

What is claimed is:

1. A communications network comprising:

a master unit;

a plurality of remote units communicating with said master unit in a multidrop configuration;

wherein each of said remote units execute at least one application program, at least one of said remote units executing at least two application programs, said remote units receiving messages outbound from said master unit and responding in a time slot assigned to each of said application programs;

said master unit including a master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said application programs in said one of said remote units is assigned to transmit to said master unit in a time division multiple access fashion; and

said master unit including ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units, each of said respective remote units using said transmission time to adjust initiation of said time slots.

2. The network of claim **1** wherein said remote units include a reservation request generator which activates a reservation request bit for requesting an additional time interval inbound to said master unit, and wherein said master unit includes a reservation request processor communicating to said master network timing means, said reservation request processor being responsive to said reservation request bit.

3. The network of claim **2** wherein said master unit initiates communication with said remotes using half duplex polled protocols.

4. The network of claim **3** wherein communication from said remote units to said master unit is in the form of modulated bursts on an analog carrier frequency.

5. The network of claim **4** wherein communication from said remote units is received by a burst equalizer in series with a burst automatic gain control in said master unit, said burst equalizer and said burst automatic gain control being responsive to operating parameters which are dependent upon which of said remote units is scheduled to transmit.

6. The network of claim **5** wherein said operating parameters are calculated in an initial training period and stored in said master unit.

7. The network of claim **6** wherein said operating parameters are indexed in said master unit and advanced from said master unit to said burst equalizer and said automatic gain control in response to a preamble unique to each of said remote units which is communicated from said remote units to said master unit.

8. The network of claim **3** wherein communication from said remote units to said master units is in digital form.

9. The network of claim **8** wherein communication between said remote units and said master unit is encoded using baseband modulation.

10. The network of claim **3** wherein said master unit includes a master network clock with a period which is divided into a plurality of subframes, each corresponding to transmission time for one of said remote units, and wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said applications programs in said one of said remote units transmits to said master unit.

11. The network of claim **2** wherein said time slot comprises a format so as to include a preamble, a poll response data bit, said reservation request bits, at least one priority bit and error detection bit.

12. The network of claim **1** wherein the master unit includes means for calculating clock drifts of the remote units and issuing reset commands to correct the same whereby each remote unit determines its transmit epoch accurately, thereby minimizing guard time while maintaining contention-free transmission to said master unit, said means for calculating clock drifts and issuing reset commands being in communication with said master network timing means.

13. The network of claim **4** wherein said bursts occur at a burst rate which is greater than an aggregate port rate of said remote units.

14. A method for a plurality of remote units to operate a plurality of application programs in communication with a master unit in a multidrop configuration, comprising the steps of:

calculating and storing in said master unit inbound and outbound transmission times between the master unit and said remote units;

dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one of said remote units, and assigning a slot to each of said application programs in said one of said remote units;

transmitting from said master unit to each of said respective remote units the transmission time between said master unit and said respective remote unit, each of said respective remote units using said transmission time to adjust initiation of said slots; and

transmitting data from each of said remote units to said master unit in a time division multiple access configuration wherein each application in each remote unit transmits during said assigned subframe.

15. The method of claim **14** further comprising the step of initiating communication between said master unit and said remote units by using half-duplex polled protocols.

* * * * *

Exhibit 3

US005852631A

United States Patent [19]

Scott

[11] **Patent Number: 5,852,631**

[45] **Date of Patent: *Dec. 22, 1998**

[54] **SYSTEM AND METHOD FOR ESTABLISHING LINK LAYER PARAMETERS BASED ON PHYSICAL LAYER MODULATION**

[75] Inventor: **Robert Earl Scott**, Indian Rocks Beach, Fla.

[73] Assignee: **Paradyne Corporation**, Largo, Fla.

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,710,761.

[21] Appl. No.: **780,762**

[22] Filed: **Jan. 8, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/026,970, Sep. 20, 1996, and provisional application No. 60/022,474, Jun. 21, 1996.

[51] **Int. Cl.**[6] **H04L 29/10**

[52] **U.S. Cl.** **375/222**; 379/93.32

[58] **Field of Search** 375/222, 223; 379/93.29, 93.31, 93.32, 93.33, 120; 370/252

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,905,282	2/1990	McGlynn et al.	380/48
4,931,250	6/1990	Greszczuk	375/222
5,317,594	5/1994	Goldstein	375/222
5,425,080	6/1995	Abbie	379/91.01
5,491,720	2/1996	Davis et al.	375/222
5,710,761	1/1998	Scott	370/252

FOREIGN PATENT DOCUMENTS

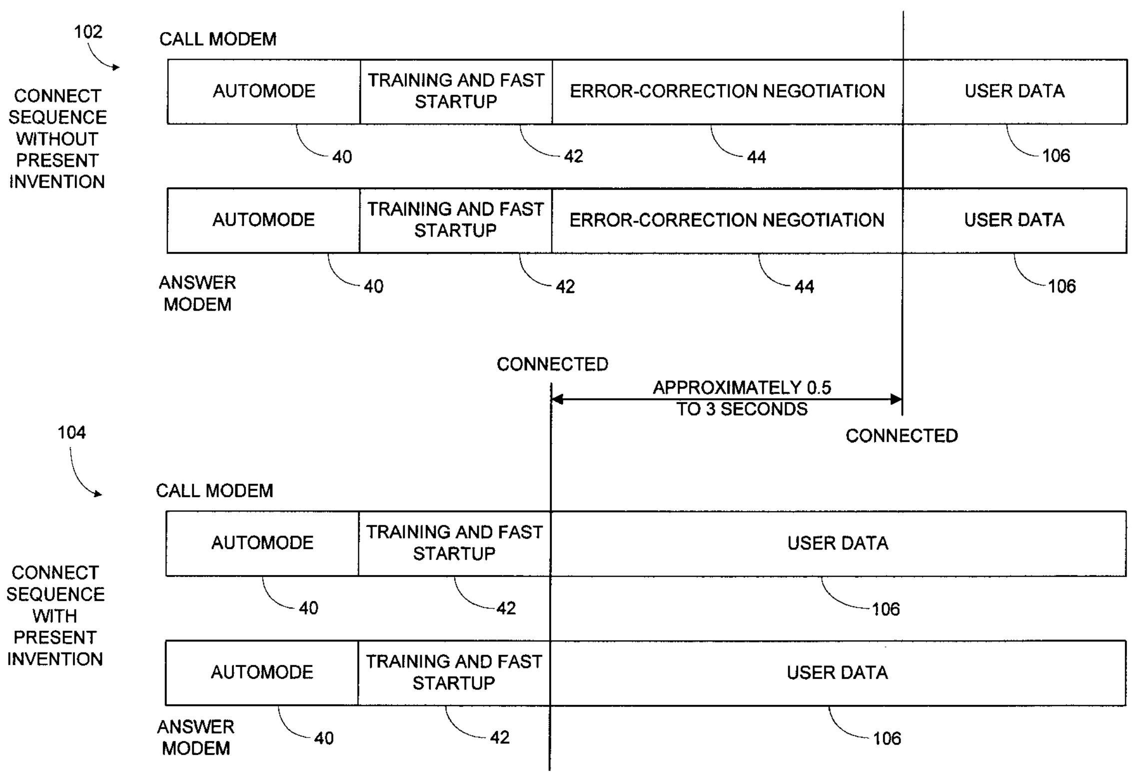
0 418 165	3/1991	European Pat. Off.	375/222

Primary Examiner—Stephen Chin
Assistant Examiner—Jeffrey W. Gluck
Attorney, Agent, or Firm—Thomas, Kayden, Horstemeyer & Risley, L.L.P.

[57] **ABSTRACT**

A system and method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and one or more possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and one or more possible link layer connections comprising the steps of establishing a physical layer connection between the calling and the answering modems, wherein the physical layer connection is based on a negotiated physical layer modulation chosen from the first and second physical layer modulations, and establishing link layer connection based upon said negotiated physical layer modulation. The link layer connection includes parameters that are preset to default values based upon the negotiated physical layer connection. Thus, the modems are able to avoid the link layer negotiation, thereby providing a faster and more robust connection.

10 Claims, 8 Drawing Sheets



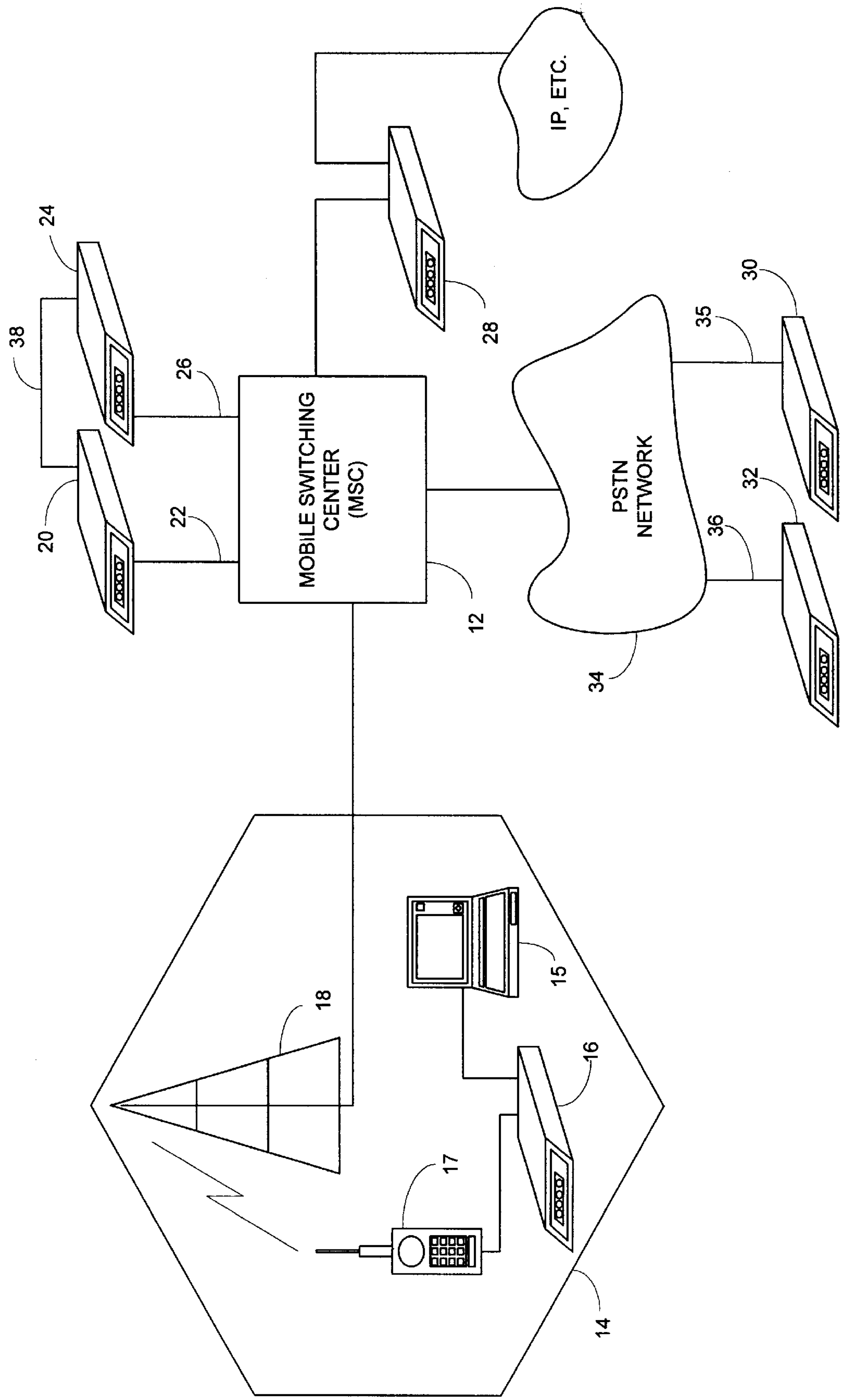

IP, ETC.
MOBILE SWITCHING CENTER (MSC)
PSTN NETWORK
12
14
15
16
17
18
20
22
24
26
28
30
32
34
35
36
38

FIG. 1

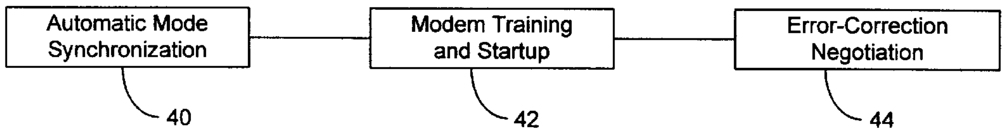

Automatic Mode Synchronization
Modem Training and Startup
Error-Correction Negotiation
40
42
44

FIG. 2

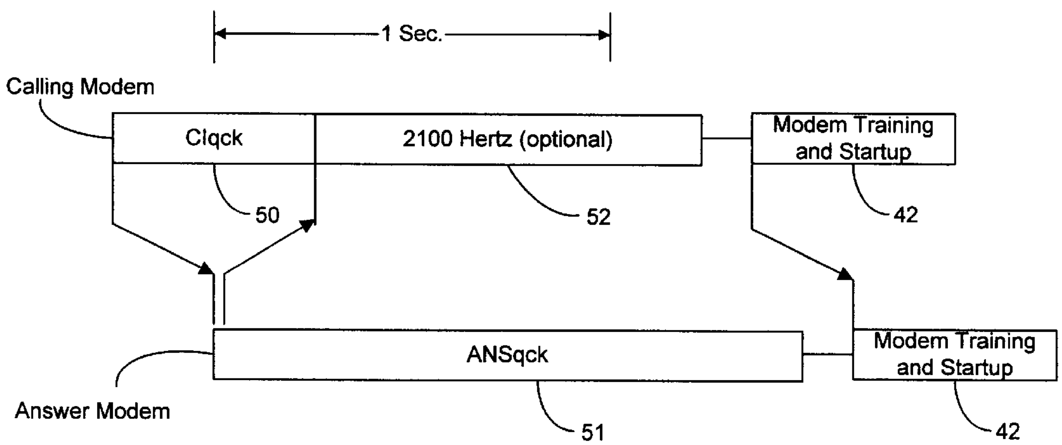
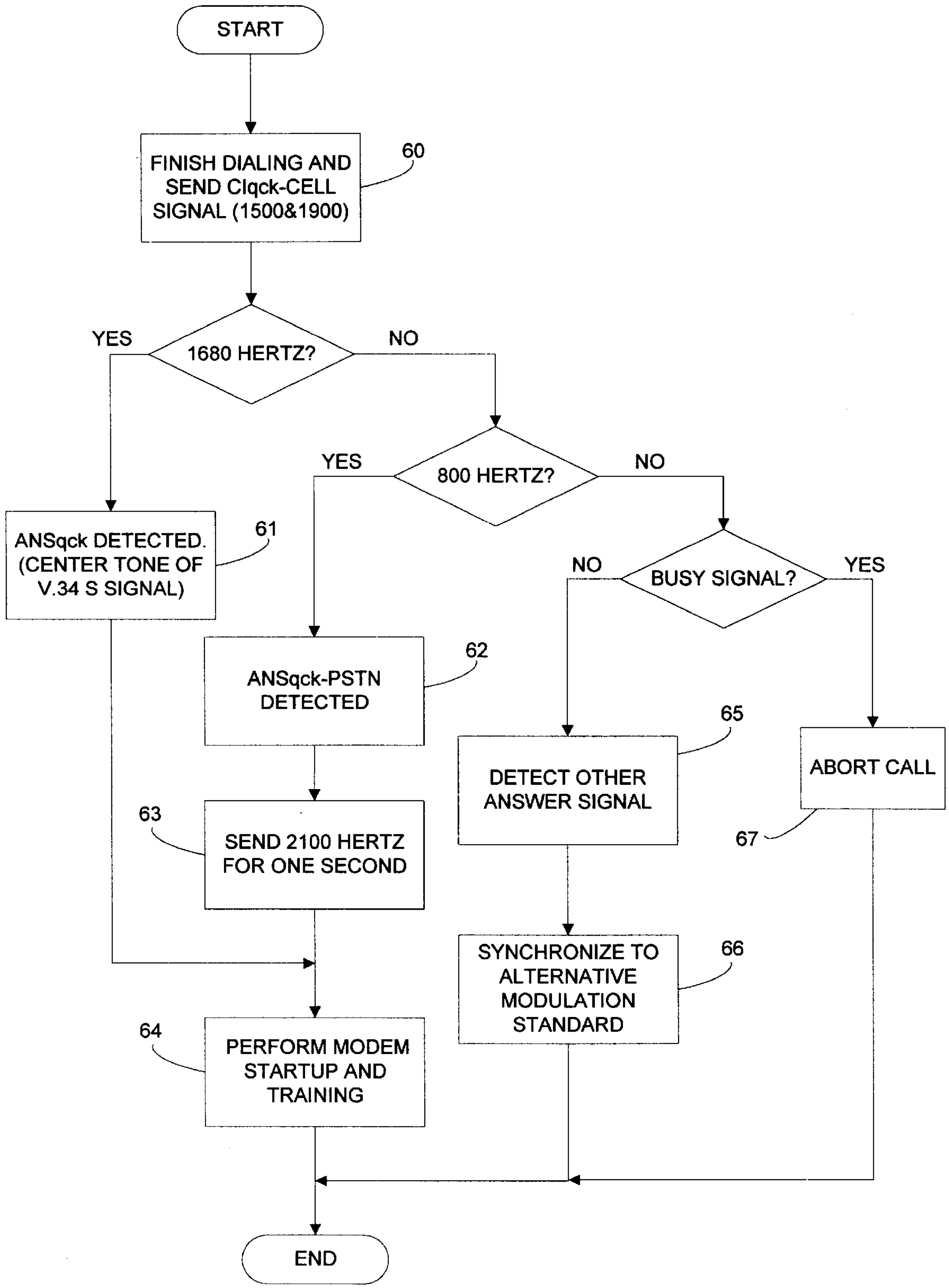
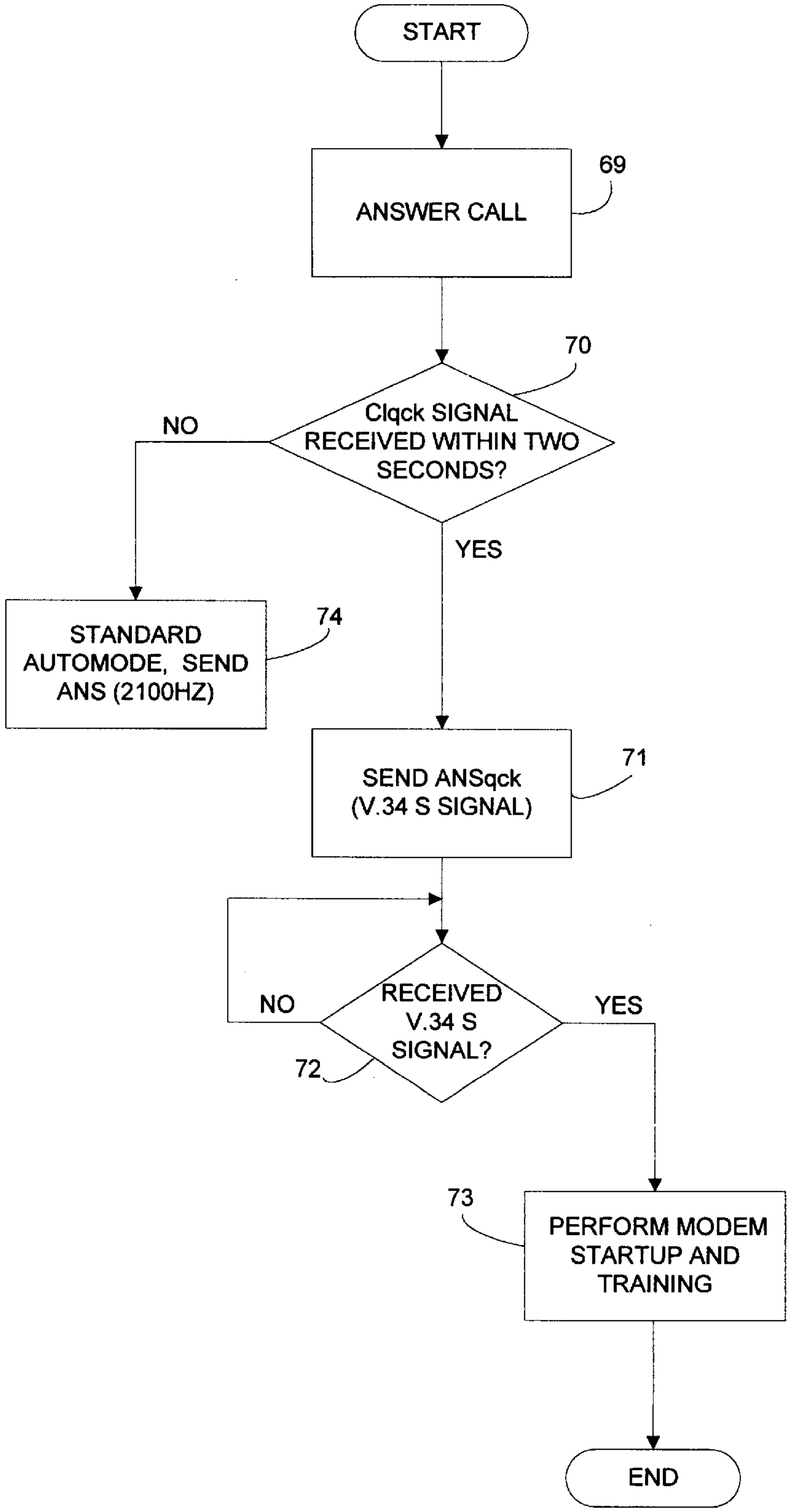

1 Sec.
Calling Modem
Clqck
2100 Hertz (optional)
Modem Training and Startup
50
52
42
ANSqck
Modem Training and Startup
Answer Modem
51
42

FIG. 3

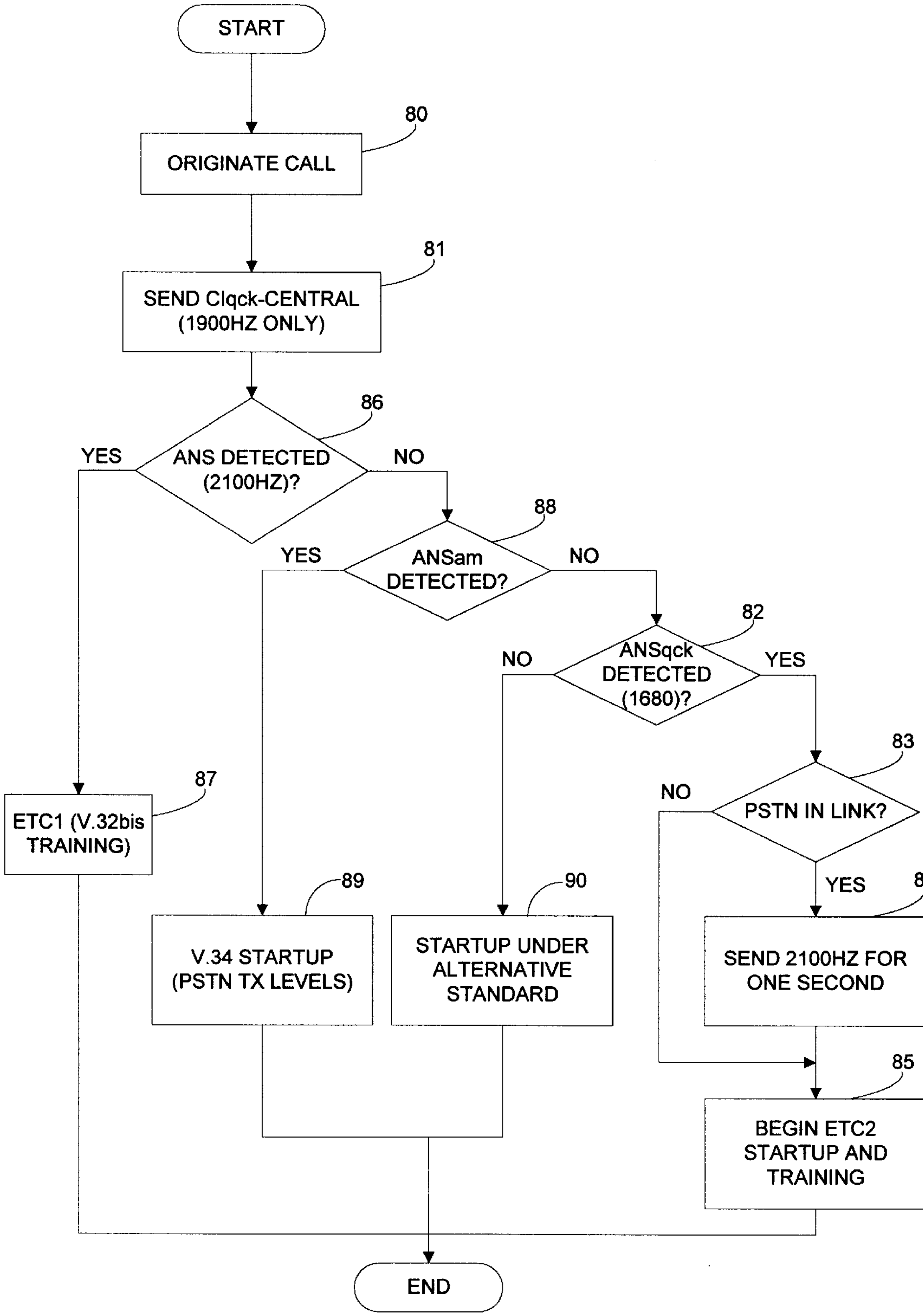


Calling Modem -- Cellular

FIG. 4

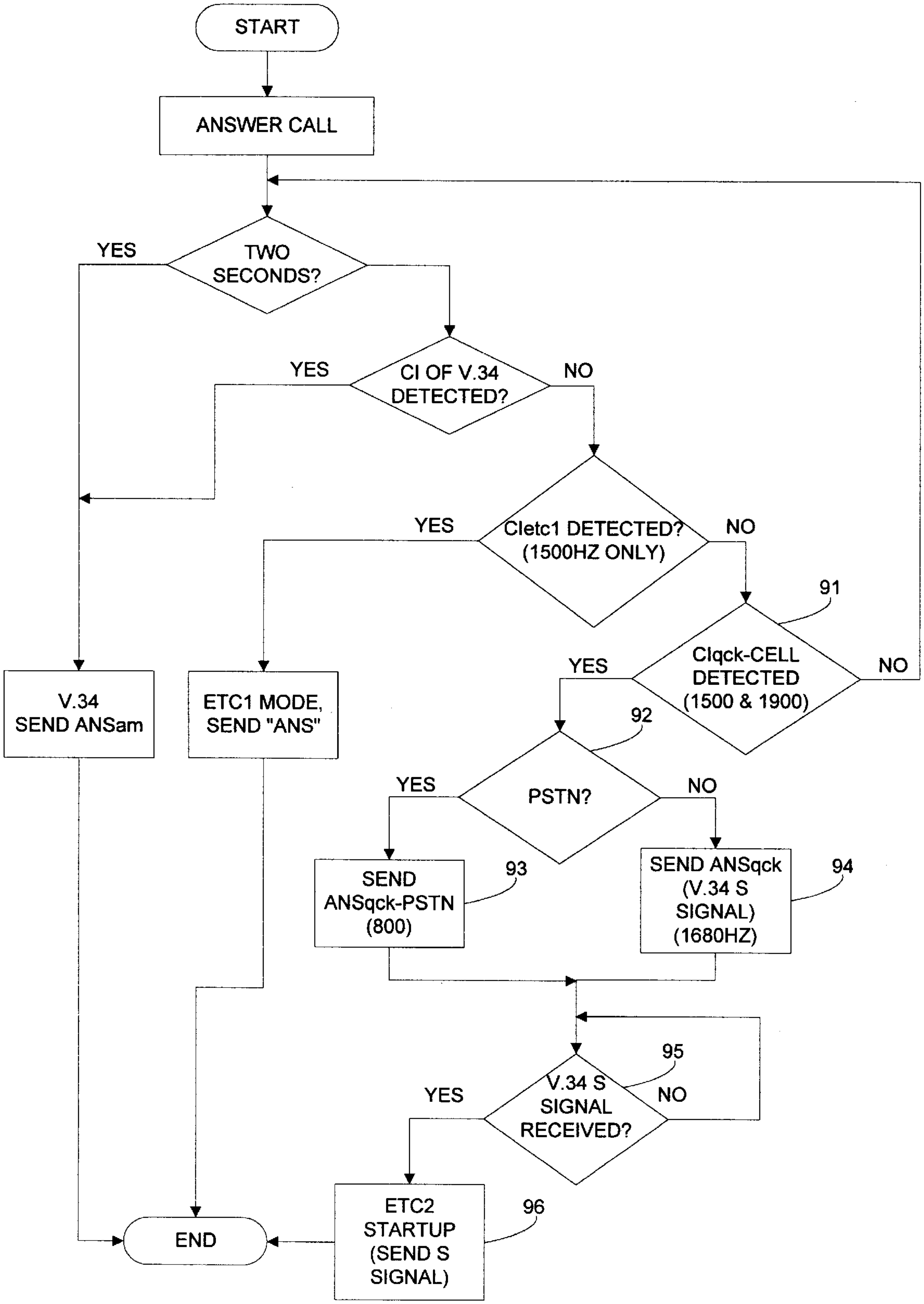


Answer Modem -- Cellular
FIG. 5



Calling Modem -- Central Site

FIG. 6



Answer Modem -- Central Site

FIG. 7

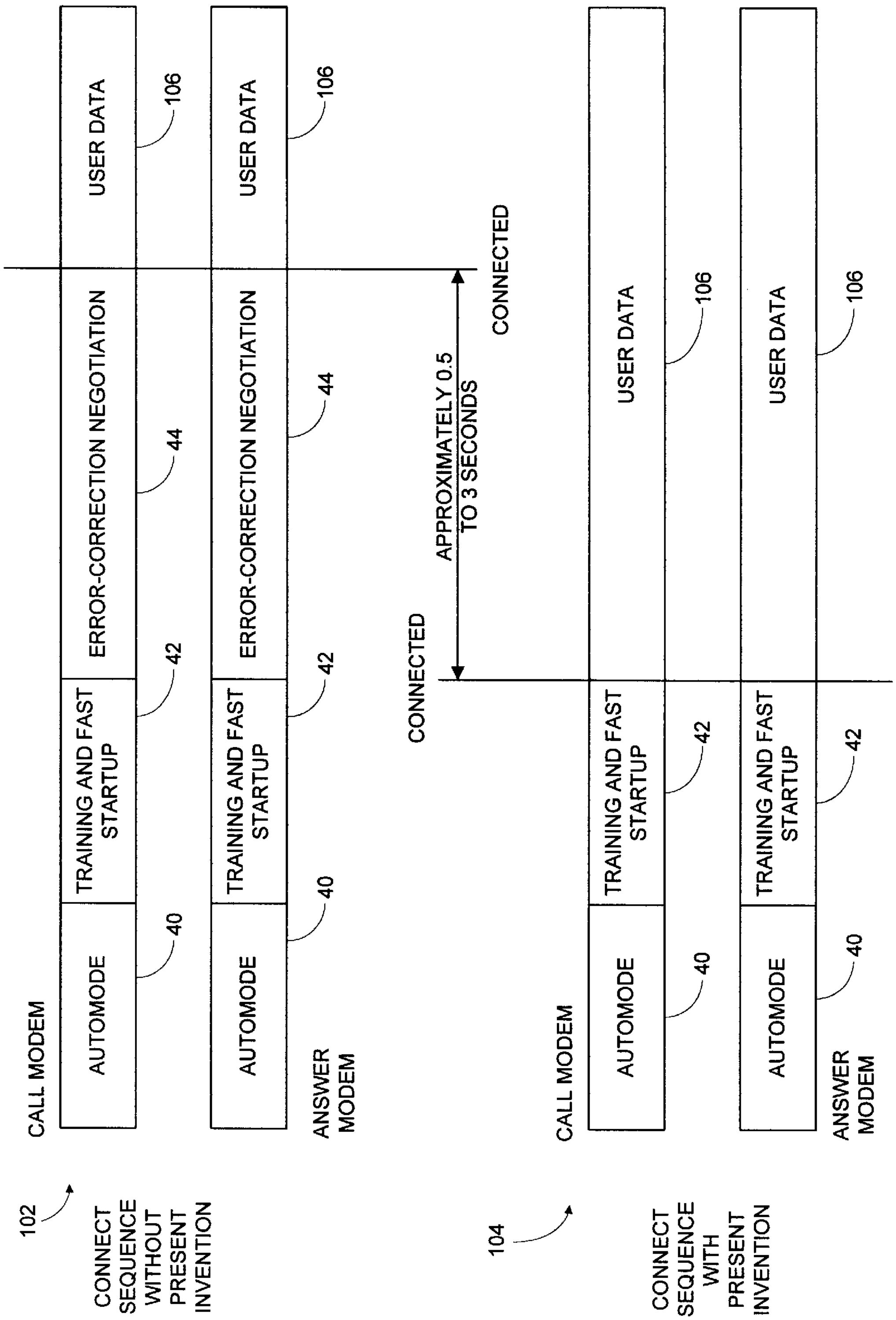

102
CONNECT SEQUENCE WITHOUT PRESENT INVENTION
CALL MODEM
AUTOMODE
40
TRAINING AND FAST STARTUP
42
ERROR-CORRECTION NEGOTIATION
44
USER DATA
106
AUTOMODE
40
TRAINING AND FAST STARTUP
42
ERROR-CORRECTION NEGOTIATION
44
USER DATA
106
ANSWER MODEM
CONNECTED
APPROXIMATELY 0.5 TO 3 SECONDS
CONNECTED
104
CONNECT SEQUENCE WITH PRESENT INVENTION
CALL MODEM
AUTOMODE
40
TRAINING AND FAST STARTUP
42
USER DATA
106
AUTOMODE
40
TRAINING AND FAST STARTUP
42
USER DATA
106
ANSWER MODEM

FIG. 8

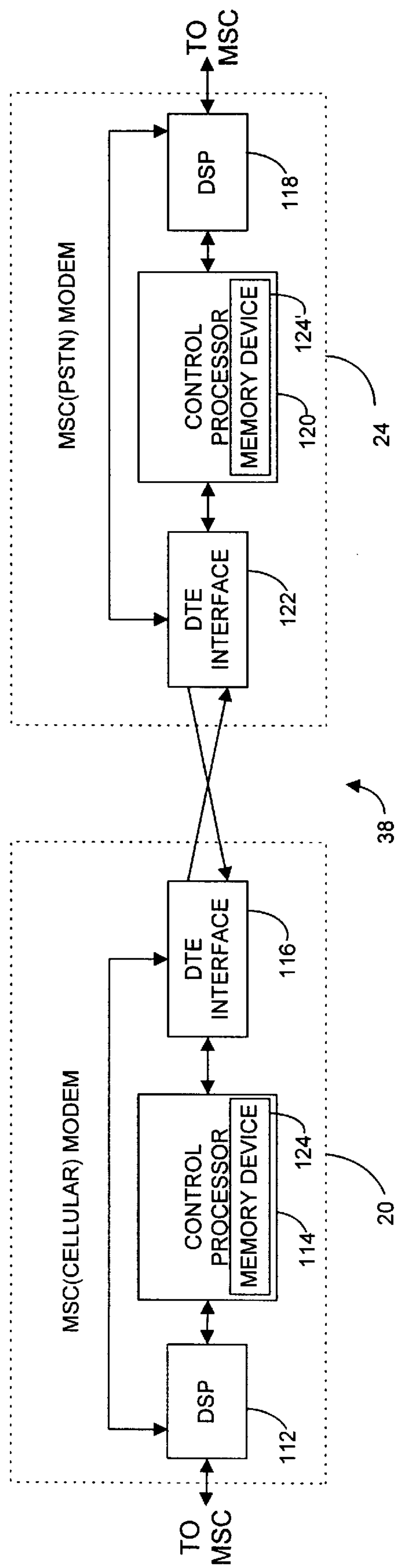

TO MSC
DSP
118
CONTROL PROCESSOR
MEMORY DEVICE
124
120
24
DTE INTERFACE
122
MSC(PSTN) MODEM
38
DTE INTERFACE
116
CONTROL PROCESSOR
MEMORY DEVICE
124
114
20
DSP
112
MSC(CELLULAR) MODEM
TO MSC

FIG. 9

SYSTEM AND METHOD FOR ESTABLISHING LINK LAYER PARAMETERS BASED ON PHYSICAL LAYER MODULATION

This application claims priority to and the benefit of the filing date of copending and commonly assigned provisional application entitled CELLULAR DATA PROTOCOL FOR QUICK CONNECTION, assigned Ser. No. 60/026,970, and filed Sep. 20, 1996; and copending and commonly assigned provisional application entitled A RAPID START UP PROTOCOL FOR COMMUNICATION BETWEEN A PLURALITY OF MODEMS, assigned Ser. No. 60/022,474, and filed Jun. 21, 1996.

FIELD OF THE INVENTION

The present invention generally relates to data communication protocols, and more particularly, to presetting the link layer parameters per the physical layer modulation in a protocol stack for modems.

BACKGROUND OF THE INVENTION

In an effort to facilitate more reliable and platform independent communication links between remotely located computers, communication protocols are typically organized into individual layers or levels comprising a protocol stack. The lowest layer is designed to establish host-to-host communication between the hardware of different hosts. The highest layer, on the other hand, comprises user application programs which pass customer data back and forth across the communication link. Each layer is configured to use the layer beneath it and to provide services to the layer above it.

Examples of two protocol stacks are the Opened Systems Interconnect (OSI) seven layer model and the Transmission Control Protocol/Internet Protocol (TCP/IP) five layer model. The OSI seven layer model comprises the following layers from lowest to highest: a physical layer, a data link layer, a network layer, a transport layer, a session layer, a presentation layer, and an application layer. When combined, the seven layers form a protocol stack that is designed to provide a heterogeneous computer network architecture. The TCP/IP five layer model comprises the following layers from lowest to highest: a physical layer, a data link layer, a network layer, a transport layer, and an application layer. Of particular relevance to the present invention is the implementation of the physical layer and data link layer in these systems.

The physical layer of the OSI model is the lowest layer and is concerned with establishing the electrical and mechanical connection between two modems. The data link layer is the second lowest layer of the OSI seven layer model and is provided to perform error checking functions as well as retransmitting frames that are not received correctly.

As is well known, a variety of standards exist which govern the protocols for communication between modems. For example, V.21, V.22, V.32, V.32bis, V.34, V.42, and V.42bis, are identifiers of differing communication standards recommended by the International Telecommunications Union (ITU). Each one of these is directed to an aspect of either the physical layer or data link layer of the OSI model.

The ITU Standard V.34 (hereafter referred to as V.34) is intended for use in establishing a physical layer connection between two remotely located computers over the Public Switch Telecommunications Network (PSTN). The V.34 standard includes the following primary characteristics: (1) full and half-duplex modes of operation; (2) echo cancellation techniques for channel separation; (3) quadrature amplitude modulation for each channel with synchronous line transmission at selectable symbol rates; (4) synchronous primary channel data signaling rates ranging from 2,400 bits per second to 33,600 bits per second, in 2,400 bit-per-second increments; (5) trellis coding for all data signaling rates; and (6) exchange of rate sequences during start-up to establish the data signaling rate. The features of V.34 are documented in the publicly-available ITU Standard V.34 Specification and are well known by those skilled in the art, and will not be described in detail herein.

Another significant feature of V.34, as it relates to the present invention, is the ability to automode to other V.-series modems that are supported by the ITU Standard V.32bis automode procedures. In this regard, V.34 defines signal handshaking that two connecting modems exchange at startup in order to learn the capabilities of the other modem to most efficiently exchange information.

While V.34 achieves efficient and generally high speed communication between two communicating modems, it nevertheless possesses several shortcomings that impede even more efficient operation. One significant shortcoming is the lengthy startup sequence which takes approximately 10–15 seconds. Particularly, for cellular customers, the ability to provide faster connections and faster data rates is particularly desirable since the cellular customer typically pays a charge for each cellular call based primarily on the length of the call and several other factors such as day of the week, time of day, roaming, etc. As a result, new fast connect protocols are being developed that provide for faster and more efficient startup operation based upon the system configuration and the path of the established communication link. An example of one such fast connect protocol is Paradyne Corporation's Enhanced Throughput Cellular 2 Quick Connect™ (ETC2-QC™). In essence, the ETC2-QC™ protocol uses techniques in the physical layer to reduce the physical layer startup time delay to about 1 second.

Of particular relevance to the present invention is the ITU Standard V.42 (hereinafter referred to as V.42). The V.42 standard is intended for use in establishing the error-correcting protocol of the data link layer connection. The V.42 standard includes a detection phase which determines whether both modems are capable of a an error-corrected connection, an exchanging identification phase for determining error-correcting parameter values and a link establishment phase for establishing the error-corrected connection. Under normal circumstances, V.42 requires approximately 1–3 seconds to establish an error-corrected connection. While this is relatively small in comparison to the establishment of a physical layer connection under V.34, it can essentially double the connection time when used in conjunction with fast connect modems.

Therefore, a heretofore unaddressed need exists in the industry for a system and method that reduces or eliminates the time required to establish a link layer connection so as to minimize the amount of time for establishing a connection between two modems.

SUMMARY OF THE INVENTION

The present invention overcomes the inadequacies an inefficiencies of the prior art as discussed hereinbefore and well known in the industry. The present invention provides a system and method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link

layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections that comprises the following steps. One step includes establishing a physical layer connection between the calling and the answering modems, wherein the physical layer connection is based on a negotiated physical layer modulation chosen from the first and second physical layer modulations. Another step includes establishing a link layer connection based upon the negotiated physical layer modulation. This link layer connection includes parameters that are preset to default values based upon the negotiated physical layer connection. Thus, the modems are able to avoid the link layer negotiation that essentially all other modems perform, thereby providing a faster and more robust connection.

Other features and advantages of the present invention will become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional features and advantages be included herein within the scope of the present invention, as defined by the claims.

DESCRIPTION OF THE DRAWINGS

The present invention can be better understood with reference to the following drawings. The elements of the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. Furthermore, like referenced numerals designate corresponding parts throughout the several views.

FIG. **1** is a system diagram, illustrating a multi-modem system, wherein a plurality of modems are interconnected among a plurality of communication links;

FIG. **2** is a diagram illustrating the primary handshaking and data exchange sequences between a calling and an answer modem;

FIG. **3** is a timing diagram similar to FIG. **2**, illustrating the signal exchange during the automatic mode synchronization sequence of FIG. **2**;

FIG. **4** is a software flowchart illustrating the operation of the present invention when the calling modem is a cellular modem;

FIG. **5** is a software flowchart illustrating the operation of the present invention when the answer modem is a cellular modem;

FIG. **6** is a software flowchart illustrating the operation of the present invention when the calling modem is a Central-site modem;

FIG. **7** is a software flowchart illustrating the operation of the present invention when the answer modem is a Central-site modem;

FIG. **8** is a schematic diagram comparing a first connect sequence of two fast connect modems with a conventional link layer connection and a second connect sequence of two fast connect modems with a link layer connection based on the physical layer negotiation in accordance with the present invention; and

FIG. **9** is a block diagram of the modems comprising a data gateway connected to the mobile switching center of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is of the best presently contemplated mode of carrying out the present invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of describing the general principles of the invention. Consequently, the scope of the invention should be determined by referencing the appended claims.

The following description is divided into two parts. The first part discloses an example of a fast connect protocol for use in a modem system that is suitable for operating in conjunction with the present invention. It should be noted that the modem system disclosed in the first part is merely illustrative of a system that can benefit from the present invention, as will be evident to those of ordinary skill in the art upon reading the following disclosure. The second part discloses the present invention in the context of the fast connect modem system described in the first part. However, the present invention is equally well suited for application outside the context of the fast connect modem system described herein, for example, with modems that connect slowly.

I. Physical Layer Connection

Turning now to the drawings, FIG. **1** shows a system diagram of a system illustrating multiple modems intercommunicating through a variety of mediums, including cellular and PSTN. Indeed, as previously mentioned, a driving factor in the development of the present invention was to design a system that provided improved reliability in data communication over a data communication link. This goal has been achieved by removing the necessity to perform error-correction negotiation during the connect sequence in modem communication so as to reduce the overall connection time.

As illustrated, a cellular modem system may be disposed for communication with a mobile switching center (MSC) **12**. More specifically, a cell **14** includes a portable computer **15** that is connected via a cellular modem **16** to a cellular phone **17**, which in turn communicates (wirelessly) with a cell tower **18** that communicates with the MSC **12**. It is appreciated that the modem **16** recognizes that it is on the cellular side via a strap or configuration setting, or alternatively by a direct connect sensing of the cellular phone. Therefore, and as will be discussed in more detail below, the modem **16** will know that it is capable of communicating in accordance with a modulation standard capable of performing a fast connect sequence as described below.

The MSC **12** is also connected to a data gateway comprising modems **20** and **24**. The modems **20** and **24** are illustrated as connected in a back-to-back configuration and communicating to the MSC **12** over links **22** and **26**. As will be appreciated and discussed below, the links **22** and **26** will support different communication protocols, or different modulation standards. The modem pool provides a data gateway for interfacing data calls originating from the modem **16**, and thereby, allows cellular specific protocols to be used over the wireless connection between modems **16** and **20**, as described below.

By way of definition, a "Central-site" modem is one that is capable of supporting the modulation standard of the present invention, and is not connected to a cellular phone. In this regard, all central-site modems are connected via four-wire connections. Examples which are illustrated in FIG. **1** include a mobile switching center MSC(Cellular) modem **20**, an MSC(PSTN) modem **24**, an MSC(Single-ended) modem **28**, and a PSTN(ETC2-QC™) modem **30**—where an MSC modem is one that is connected at the mobile switching center **12**. A significant distinction among these various types of modems relates to the startup sequence, which will differ slightly depending upon the type

of central-site modem. Preferably, a hardware identifier, such as a DIP switch or a firmware option configurable at modem installation, defines the type of modem for purposes of the startup sequence.

In keeping with the description of FIG. **1**, modem **20** is illustrated as an MSC(Cellular) modem that is connected in a back-to-back mode with modem **24**, an MSC(PSTN) modem. Modem **20**, therefore, is designed to support the ETC2-QC™ modulation protocol and simulate a cellular modem during the initial modem startup routine. Modem **28** is an MSC(Single-ended) modem that, although it may communicate with modems on the PSTN **34**, will typically communicate only with cellular modems. Indeed, when communicating with cellular modems, the 2100 Hertz tone, which is typically inserted to disable echo cancellers, is preferably omitted. Advantageously, elimination of this tone achieves a faster and more desirable modem startup.

A PSTN(ETC2-QC™) modem **30** and a standard PSTN modem **32** are connected via PSTN **34** to the MSC **12**. The modem **30** is connected to the PSTN **34** via a four-wire connection **35**, and modem **32** via a two-wire connection **36**. Consistent with the concepts and teachings of the present invention, the four-wire connection **35** facilitates the communication of modem **30** with the cellular modem **16**, for example, in the ETC2-QC™ modulation standard. However, as will be appreciated by those of ordinary skill in the art, merely ensuring a four-wire connection **35** alone will not ensure proper system operation in accordance with the present invention. In this regard, such a four-wire connection **35** may nevertheless pass through a two-wire connection, and thus a hybrid converter circuit, at the central office. In this event, echo will be injected into the signal and the abbreviated modulation standard of the present invention may be compromised. There are, however, steps that may be taken to ensure proper operation of the invention. These include, (1) ordering a Direct Inward Dial connection and instructing the phone company to avoid a two-wire connection for that setup; (2) obtaining a direct T**1** connection to the Interexchange Carrier (for example, a "1-800" number); and obtaining an ISDN PRI connection, as it will always support four-wire for both call origination and call answer.

By way of illustration, consider a call originated by the computer **15** and cellular modem **16** to the standard PSTN modem **32**. The established communication link will pass through the cellular phone **17** to the cell tower **18**, through the MSC **12**, across link **22** to the MSC(Cellular) modem **20** and to the connected modem **24** via RS-232 connection **38**, across link **26** and back through the MSC **12** to the PSTN **34**, and ultimately across the two-wire link **36** to modem **32**. As will become clear from the description that follows, the cellular modem **16** and the MSC(Cellular) modem **20** will connect and startup in accordance with the fast connect communication protocol described herein. However, since the established communication link that passes from modem **24** to modem **32** passes through a PSTN **34** and a hybrid converter, then the communication protocol of the present invention will not be adequately supported. Accordingly, the modems **24** and **32** will identify this situation and will connect and communicate using an alternative communication protocol supported by both modems and capable of effective transmission across the established link. In this regard, the overall communication link does not realize the fast connection.

Indeed, an aspect of the fast connect protocol described herein is the determination of whether both modems are compatible, in terms of communication protocol, and whether they are connected through a line that passes through a PSTN. If the modems are compatible and the established communication link is outside a PSTN (e.g., cellular to MSC) or is to a PSTN modem with a 4-wire connection that has been configured for supporting a fast connect protocol, then the modems may connect and begin their startup sequence. In this regard, the fast connect communication protocol is designed to be fast as well as robust, and is accomplished by the use of simple tones. The use of such simple tones facilitates the implementation of the automatic mode select to be in the modem's control processor rather than the digital signal processor (DSP) chip.

In addition to the fast connect protocol discussed in below, the fast connect protocol also includes several "fall-back" modulations. More particularly, the modem of the present invention will preferably include Paradyne Corporation's Enhanced Throughput Cellular 1™ (ETC1™), V.34, V.32bis, V.32, and V.22bis modulations. Thus, in the previous example, modems **24** and **32** may communicate using one of these communication protocols. These modulation protocols are documented and will be understood by persons of ordinary skill in the art, and will not be discussed herein. It suffices to say that supporting the above-listed modulation standards greatly enhances the flexibility and versatility of a fast connect modem.

To more particularly describe the initial startup sequence in accordance with the modulation standard of the fast connect modem, reference is made to FIGS. **2** and **3**. FIG. **2** illustrates the three principal components of modem exchange or communication. After the cellular modem initiates the call, such that a communication link is established, the modems enter a mode select sequence, referred to herein as automatic mode synchronization **40**. During this period, the modems exchange parameters that identify the modems, and thus, their communication protocol. This sequence **40**, thus, synchronizes the modems for communication in accordance with the same standard or protocol, such as V.34, V.22, V.22bis, etc.

Once the modems have synchronized their communication protocol, or modulation standard, then they enter a training and startup sequence **42**. In a manner known in the art, during this sequence the modems may test the established communication link for noise, bandwidth, etc., in order to determine an appropriate rate for communication. The modems may also operate during this period to train their internal echo cancellers by, for example, ranging the established link of communication. In accordance with a related aspect of the fast connect modems, under certain circumstances the modem training and startup sequence may also be significantly shortened to provide a more robust (both time-shortened and reliable) startup sequence. More particularly, the "circumstances" which provide such a robust startup include communicating modems constructed in accordance with the invention detecting an established link of communication that does not pass through any two-wire connections. The completion of this sequence signifies the establishment of a physical layer connection between two modems.

After the physical layer has been established, the communicating modems enter the information exchange/communication sequence, referred to herein as error-correction negotiation **44**, in order to establish the link layer connection. This is of particular relevance to the present invention in that it includes negotiation of a error-correcting protocol such as V.42. During this sequence **44**, the modems detect whether they are error-correcting modems and, if so, they negotiate the error-correcting parameters.

Referring now to FIG. **3**, the initial automatic mode synchronization **40** is illustrated. As shown, this sequence is

executed by exchanging signals between the calling modem and the answer modem. After the calling modem instructs the cellular phone to establish the communication link with the answer modem, it transmits the calling signal CIqck **50**. As will be described in more detail in connection with the flowcharts of FIGS. **4–7,** this signal may comprise a 1900 hertz tone, or alternatively may comprise a 1500 hertz tone modulated with a 1900 hertz tone. If only a 1900 hertz tone is transmitted as Ciqck signal **50**, then the answer modem knows that the calling modem is configured as a Central Site, four-wire modem (see FIG. **6**). Alternatively, if the CIqck signal includes both 1500 and 1900 hertz components, then the answer modem knows that the calling modem is configured as a cellular modem.

As will be appreciated by those of ordinary skill in the art, other calling signals may be transmitted by the calling modem. For example, calling signals consistent with that of a facsimile transmission, or calling signals consistent with other modem modulation standards, such as V.34, V.32, V.32bis, etc., may be transmitted. Since automatic connection and synchronization to facsimile, and these other modulation standards, are well known it will not be discussed herein. Indeed, the significance of the fast connect protocol is achieved when both the calling modem and the answer modem are capable of communicating in accordance with the fast connect modulation protocol herein described so that through the exchange of tones, the modems are made aware of the possible shortcuts in the fast startup and training sequence **42**, and more particularly, in the error-correction negotiation **44**.

Once the CIqck signal **50** is received by the answer modem, then the answer modem transmits its response back to the calling modem. The purpose of this answer signal is not only to signal receipt of the calling signal, but also to uniquely identify the answer modem. Again, as is known in the art, this answer signal may comprise ANS or ANSam signals as are known by the V.34 and V.32bis communication protocols. If so, the calling modem will then startup and train **42** and perform error-correction negotiation **44**. Significant to the present invention, however, is when the answer signal is ANSqck, which is defined by either a 1680 hertz tone or an 800 hertz tone.

As illustrated in FIG. **4** (assuming the calling modem is a cellular modem), if ANSqck is an 800 hertz tone, then the calling modem knows that the answer modem is configured as a four-wire connection, and can communicate with the calling modem in accordance with the fast connect communication protocol and, in accordance with the present invention, set the error-correction parameters to preset values so as to avoid the necessity of negotiating the parameters. In addition, the 800 hertz ANSqck signals the calling modem that the answer modem is connected to a PSTN **34** (see FIG. **1**). Therefore, the calling modem transmits a 2100 hertz tone for approximately one second. This, as is known, serves to pad the initial two second connect period, as required by the FCC for billing purposes. Furthermore, it serves to disable the echo cancellers within the PSTN **34**.

If ANSqck is a 1680 hertz tone, which is the center tone of V.34 S signal, then the calling modem knows that the answer modem is configured as a four-wire connection, and can again communicate with the calling modem in accordance with the fast connect communication protocol and, in accordance with the present invention, set the error-correction parameters to preset values so as to avoid the necessity of negotiating the parameters. More significantly, it tells the cellular calling modem that the answer modem is not connected to the PSTN **34**. Therefore, both the calling modem and the answer modem can determine that the established communication link is entirely outside the PSTN **34**. Accordingly, the Federal Communications Commission (FCC) billing delay need not be inserted. Furthermore, certain assumptions may be made in regard to bandwidth, or transmission quality. For example, the established communication link will not pass through echo cancellers, and as a result, the calling modem need not transmit the 2100 hertz tone. Instead, upon receiving the ANSqck answer signal, the calling modem may immediately enter the modem training and startup sequence **42**.

As will be further appreciated by those of ordinary skill in the art, by making certain assumptions regarding the line quality of the established link, the modem training and startup sequence **42** may be shortened. For example, in the preferred embodiment, the system initiates communication by assuming a 9600 baud rate. It has been found that most cellular connections may transmit at this rate, and certain front-end savings may be realized by defaulting to this initial startup rate. Of course, this rate may be increased, or autorated upwardly, in accordance with methods known in the prior art, after the initial startup and training sequence **42** has been completed.

Referring back to FIG. **4**, a top-level flowchart is shown, illustrating the automatic mode synchronization of a cellular calling modem constructed in accordance with the fast connect protocol disclosed herein. Once the calling modem has completed transmitting the dialing sequence, it transmits the CIqck signal, which for a cellular calling modem includes modulated 1500 and 1900 hz tones, as indicated in block **60**. Once the calling signal has been transmitted, the calling modem will wait to receive the answer signal from the answer modem. In order to exchange data using the modified modulation standard of the present invention, the calling modem looks to receive one of two answer signals. The first valid answer signal as in 1680 hz tone, which is the center tone of the V.34 S signal, as indicated in block **61**. This tone signals to the calling modem that the answer modem is not only compatible to transmit in the fast connect modified modulation standard, but further indicates that the answer modem is connected via four wire connections, and does not interconnect to a PSTN. Accordingly, since the calling modem is a cellular modem, then the established communication link does not pass through a PSTN and the initial two second FCC-required delay need not be inserted into the start-up sequence. Moreover, since the entire communication link is four wire, then the modems need not transmit the 2100 hz signal to disable echo cancellors.

A second valid answer signal is an 800 hz tone, as shown by block **62**, which also indicates that the answer modem is connected via four wire, and therefore, can communicate in accordance with the fast connect modulation protocol. In addition, the 800 hz tone indicates that the answer modem is connected to a PSTN. Assuming, as previously discussed, that the requisite steps have been taken to ensure that the established communication link does not pass through a two wire connection, then certain savings or efficiencies can be gained during the modem start-up and training sequences (e.g., eliminate echo training since no hybrid circuits are present in the communication link). Nevertheless, the FCC-required delay must be inserted and, therefore, a 2100 hz tone is transmitted at block **63** by the calling modem for a duration of approximately one second. The amount of the 2100 hz tone will “pad” the total modem automode and startup time to two seconds. This ensures that no customer data is transferred in the first two seconds (which meets FCC requirements). Thereafter, calling modem proceeds with the modem training and start-up sequence at block **64**.

If neither of the foregoing answer signals are received, then the system operates to determine whether another valid answer signal has been transmitted from the answer modem. The step of block **65** broadly designates this function. It should be appreciated that well known answer signals such as ANS or ANSam may be transmitted by the answer modem and, if received, the calling modem may synchronize to the appropriate modulation standard, as indicated in block **66**. Although not separately designated in the figure, it should be further appreciate that if no valid answer signal is received by the calling modem within a given period of time, the calling modem will time out and abort the attempted communication. Also, and as illustrated at block **67**, the calling modem will abort the attempted communication if a busy signal is received.

FIG. **5** shows a top-level flowchart illustrating the operation of a cellular answer modem constructed in accordance with the fast connect communication protocol described herein. Once the communication link has been established and the call answered at block **69**, the answer modem looks to detect the CIqck calling signal, as indicated by block **70**. In the presently described fast connect protocol, cellular to cellular modem communications are not supported. Therefore, a cellular answer modem will assume that a calling modem transmitted a CIqck signal will transmit only a 1900 hz tone rather than the modulated 1500 and 1900 hz tones. Having said this, it should be appreciated that cellular-to-cellular communications could be supported.

In keeping with the description of FIG. **5**, once the answer modem has received the CIqck calling signal, it transmits the ANSqck answer signal at block **71**. It then waits for the calling modem to enter the modem start-up and training sequence. This sequence is identified by receiving the S signal as assigned by the V.34 modulation standard, as indicated by the decision block **72**. Once this signal is received, then the answer modem will transmit back to the calling modem the appropriate S signal, so as to initiate the startup and training sequence **42**.

Alternatively, if the answer modem, within a period of two seconds, has not received CIqck calling signal, then it will proceed with the start-up sequence in accordance with an alternative modulation standard. This, therefore, assumes that the modified communication protocol of the present invention is not supported by the calling modem, and the answer modem will typically respond to the calling signal of an alternative communication signal by transmitting a 2100 hz tone, as indicated in block **74**.

Referring now to FIG. **6**, a software flowchart illustrating the top-level operation of a central site calling modem is shown. As depicted, the calling modem originates the call and establishes a communication link at block **80**. Once the communication link is established, the calling modem transmits the CIqck calling signal at block **81**, which in the case of a central site calling modem comprises a 1900 hz signal tone. If the 1680 hz ANSqck answer signal is detected at block **82**, then the calling modem recognizes the answer modem as one capable of transmitting pursuant to the fast connect communication protocol. Thereafter, the calling modem must determine the network configuration of the established communication link, as indicated in block **83**. That is, the central site calling modem will determine whether the established communication link passes through a PSTN or not. If it is determined that the established link passes through a PSTN, then, as in the case of the cellular calling modem, the calling modem transmits a 2100 hz signal for approximately one second at block **84**. Thereafter, the calling modem enters the modem start-up and training sequence, as indicated in block **85**.

Alternatively, if the calling modem detects the ANS answer signal (2100 hz) at block **86**, then it communicates with the answer modem using the ETC1™ communication protocol and the V.32bis training, as indicated by block **87**. If the ANSam answer signal is detected at block **88**, then the modem will startup in standard V.34 mode at block **89**, which is well known in the art and therefore not described herein. The modem will also monitor for ANSqck at block **82**, which in this example is a 1680 Hz tone. If this is not detected, then the modem will startup under an alternate low speed standard at block **90**, which is well known in the art and therefore not described herein. If ANSqck is detected, then the modem will operate differently depending on whether it is connected to the PSTN network or not, as indicated by block **83**. The modem will know whether it is connected to the PSTN via a configuration option which was set at installation. If connected to the PSTN, then the modem will transmit a 2100 Hz tone for one second at block **84** then proceed to the ETC2™ training sequence at block **85**. If the modem is not connected to the PSTN at block **83**, then it can proceed directly to the ETC2™ training sequence at block **85**, avoiding the additional one second of startup shown at block **84**.

Reference is now made to FIG. **7**, which is a software flowchart illustrating the top-level operation of a central site answer modem. As illustrated in the flowchart, and in accordance with the presently disclosed fast connect protocol, when the answer modem is a central-site modem, it assumes that any transmissions made in accordance with the modulation standard with the present invention will be via a communication link with a cellular calling modem. Therefore, block **91** indicates detection the CIqck calling signal in the form of a modulated 1500 and 1900 hz tones, as transmitted by cellular calling modem. If the CIqck calling signal is detected, then the answer modem determines the network configuration at block **92**. More specifically, the answer modem determines whether the established communication link passes through a PSTN or not. In the event that the established link does in fact pass through a PSTN, then the answer modem will transmit an 800 hz ANSqck answer signal at block **93**. As illustrated in FIG. **4**, this instructs the calling modem to transmit the 2100 hz tone. Alternatively, the answer modem will transmit the 1680 hz tone, which instructs the calling modem to proceed directly with the modem start-up and training sequence at block **94**. Thereafter, the answer modem will await transmission of the S signal in accordance with the V.34 start-up sequence, as indicated by block **95**. Thereafter, the answer modem will respond by transmitting the S of the V.34 start-up, as indicated by block **96**. Since the V.34 start-up sequence is well-known in the art, it would not be described herein.

The remainder of the flowchart depicted in FIG. **7** illustrates the central-answer modem operation and connects sequence in accordance with alternative standards that are well-known in the prior art and need not be discussed herein.

Accordingly, at the completion of the automatic mode synchronization sequence **40** (FIG. **2**), the modems enter into a training and start-up sequence **42**. As mentioned above, in the training and startup sequence **42** the modems test the established communication link for noise, bandwidth, etc., in order to determine the appropriate rate for communication. This is performed using the modulation scheme determined in the automatic mode synchronization sequence **40** as illustrated in FIGS. **4**, **5**, **6**, and **7**. For purposes of the following discussion, it is assumed that the call and the answer modems are capable of communicating

with one another using a fast connect protocol. Consequently, since the call modem knows what type of modem it is and what type of modem the answer modem is, certain shortcuts can be taken during the training and startup sequence **42** so as to reduce the overall connection time. Specifically, the modems can default to preset values that eliminate the need for probing, ranging and half-duplex training. Thus, the modems merely perform a special full-duplex training mode during the training and start-up sequence **42** which results in a much faster connection.

Particularly, the probing and ranging sequences are bypassed and the file parameters are assumed in ITU Standard V.8, INFO0, and INFO1. As an example, in ITU Standard V.8, the data call, the LAPM and the full-duplex training parameters are preset to default values if the tones exchanged during automode sequence indicate that both modems are capable of fast connect operation. Further, in the INFO sequences, the 4 point train, 2800 L symbol rate, the power level drop, and preemphasis filter can also be preset to default values. Thus, the ITU Standard V.8 and INFO sequences are eliminated.

At the completion of the training and start-up sequence **42**, the modems have established a physical layer connection and are ready to establish the second layer connection, referred to as the link layer connection, via an error-correction negotiation sequence **44** in accordance with the present invention, as disclosed below.

II. Link Layer Connection

The link layer is the second layer of the ISO model protocol stack and includes negotiating and establishing an error-correcting connection such as with ITU Standard V.42 or Microcom Networking Protocol (MNP). The link layer connection follows the physical layer connection and uses the physical layer in establishing the error-corrected connection. It is noted, however, that conventional wisdom to date has maintained the link layer connection be independent of the physical layer connection when establishing a connection between two modems. In contrast, the present invention establishes the link layer connection based upon the modulation chosen in the physical layer connection during the automatic mode synchronization sequence **40** (FIG. **2**). Thus, the steps for establishing an error-correcting protocol are eliminated and the link layer connection is established substantially instantaneously upon the completion of the physical layer negotiation. This not only reduces the amount of time required to establish a connection between two modems, it makes the connection more robust by removing the necessity of performing additional handshaking that, if corrupted for whatever reason, will result in a disconnect or call connect failure.

By way of example, the ITU Standard V.42 (hereafter referred to as V.42) comprises a detection phase, and exchange identification (XID) phase, and a link establishment phase, all of which are briefly discussed below. A more detailed explanation of V.42 can be found in the publicly-available ITU (CCITT) Recommended Standard V.42 documentation.

The detection phase is provided to determine whether the answer modem supports an error-correcting protocol. This phase is designed to avoid the potential disruptions to the answer DTE that could occur if the calling modem immediately enters the XID phase and the answering modem was not capable of an error-correcting communication. However, the detection phase is optional and may be disabled. If the call modem determines that the answering modem does not support a V.42 error-correcting protocol, there are often times fall-back error protocols provided by the calling modem, such as in the case of V.42, where MNP is provided as a fall-back error-correcting protocol. Alternatively, if the answer modem does not support V.42 nor MNP, then no error-correcting protocol is established and a connect message is issued by the modems to their respective digital terminal equipment so that user data can be transmitted between the two modems.

The XID phase is provided for the negotiation of the error-correcting parameter values. These parameters essentially govern the error-correcting operation of the modems once the connection is established. As with the detection phase, the XID phase may be omitted if default parameter values are acceptable. For example, the following are provided as the default parameters values in the V.42 standard: Standard Reject, 16 bit FCS (Frame Check Sequence), V.42bis compression disabled, Frame Length (N401) of 128 octets, and Window Size (k) of 15 frames. However, the default settings are more often than not undesirable because, for example, most modems wish to negotiate Selective Reject, V.42bis data compression, and longer Frame Lengths and Window Sizes.

Lastly, the link establishment phase is provided for actually making the error-corrected connection between the two modems. In V.42, this is implemented via a set asynchronous balanced mode extended (SABME) command. The SABME command is used to place the addressed error-corrected entity (i.e., the answering modem) into the connected state. The error-correcting entity then confirms acceptance of the SABME command by the transmission of an unnumbered acknowledgment (UA) response. By acceptance of this command, the error-corrected connection is essentially established and the modems then send a connect message to their respective data terminal equipment, such as computer **15** (FIG. **1**).

Unlike the detection phase and the XID phase, the link establishment phase is not optional and must be performed under V.42. Thus, in a best case scenario, only the link establishment phase is performed, which takes approximately 0.5 seconds. If all three phases are performed, then the link layer connection may take three or more seconds.

Therefore, establishing an error-corrected connection with V.42 can take up to three seconds, depending on what defaults are set in the system. While this amount of time does not seem significant relative to the time required for establishing a physical layer connection via V.34 modulation (e.g., approximately 10–15 seconds), it is considerably more noticeable when a fast connect protocol is utilized that can establish a physical layer connection in about 1 second. Thus, when using a fast connect protocol, the error-correction negotiation can easily double the connect time, not to mention introduce a greater opportunity for failure by requiring additional handshaking.

Accordingly, the present invention enables an error-corrected connection without having to perform the steps described above with regard to V.42, or those steps associated with other error-correcting protocols as known in the art. The present invention achieves this by presetting the XID phase parameters to default values that are based upon the negotiated physical layer connection. Therefore, when two multi-mode modems negotiate a physical layer connection, the link layer connection can be immediately established based upon the negotiated physical layer modulation. For example, in the embodiment described above in Section I, the exchange of tones in the mode synchronization sequence **40** indicates to each modem the type of modem it

is communicating with, and therefore, certain assumptions can then be made regarding the error-correction negotiation sequence **44** so as to eliminate the steps normally performed to establish an error-corrected connection. In the preferred embodiment of the present invention with the V.42 standard, the following parameters are set to the indicated default values when the two modems are capable of the fast connect sequence described above: Selective Reject, 16 bit FCS, 64 bit Maximum Frame Size (transmit and receive directions), 8 Frame Window Size (transmit and receive directions), V.42bis enabled, and 1,024 bit dictionary (transmit and receive directions). It should be noted, however, that one of ordinary skill in the art would recognize that these default values are merely illustrative settings and that different default values can be used. Moreover, each different type of connect sequence would preferably have its own set of default values. If it is determined by the modems in the mode synchronization sequence **40** that one or the other is not capable of a fast connect as described above, then the modems essentially fallback and perform an alternative error-correction sequence such as the recommended ITU Standard V.42 error-correction sequence.

With reference to FIG. **8**, a graphical illustration is provided of two fast connect modems in a first connect sequence **102** where error-correction negotiation is performed without the present invention and a second connect sequence **104** where the error-correction negotiation is performed with the present invention. As shown, following the mode synchronization sequence (also referred to as automode) **40** and the training and start-up sequence **42**, the connect sequence **102** performs error-correction negotiation **44** which essentially doubles the time required for a connection to be established so as to allow user data **106** to be exchanged. In comparison, the connect sequence **104** in accordance with the present invention is able to establish a connection in essentially half the time by eliminating the error-correction negotiation **44**. Thus, by establishing the error-correction parameters to default values in accordance with the type of physical error-connection determined by the automode sequence **40**, a faster and more reliable connection is established.

Regarding the implementation of the present invention, FIG. **9** generally illustrates the components of MSC (cellular) modem **20** and MSC(PSTN) modem **24** which implement the data gateway. The MSC(cellular) modem **20** comprises a digital signal processor (DSP) **112**, a control processor **114**, and a DTE interface **116**. Likewise, the MSC(PSTN) modem **24** comprises a DSP **118**, a control processor **120**, and a DTE interface **122**. The DTE interface **116** of the MSC(cellular) modem **20** interfaces with the DTE interface **122** of the MSC(PSTN) modem **24** via the connection **38**, which can be implemented by any suitable interconnecting device such as, but not limited to, an Electronic Industry Association (EIA) standard RS-232 crossover or a backplane bus between the modems. As shown in FIG. **9**, each modem **20**, **24** is configured essentially the same, and thus, they operate in essentially the same manner. However, each modem is provided with operating code which is stored in a memory device **124**, **124**' provided with the central processor **114**, **120**, respectively, though additional memory can also be provided and connected to the control processor **114**, **120**, if necessary. In the context of the present disclosure, a memory device is a computer readable medium that is embodied in an electronic, magnetic, optical or other physical device or means that can contain or store a computer program, such as the operating code for the modem **20**, **24**, for use by or in connection with a computer related system or method. The operating code includes control logic that controls, among other things, the type of modulation and error correction techniques utilized which is dependent upon whether the modem is used for cellular or land-line connections. Accordingly, the control processor **114**, **120** operates on, or executes, the operating code that is in memory device **124**, **124**' and configured for implementing the present invention so as to control the operation of modem **20**, **24**.

The foregoing description has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment or embodiments discussed were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly and legally entitled.

Wherefore, the following is claimed:

1. A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:

establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

establishing said link layer connection based upon said negotiated physical layer modulation.

2. The method of claim **1**, wherein said negotiated physical layer modulation is a fast connect modem modulation.

3. The method of claim **1**, wherein said link layer connection is an error-correcting protocol.

4. The method of claim **1**, further comprising the step of presetting link layer parameters of said link layer connection to default settings based on said negotiated physical layer modulation.

5. The method of claim **3**, wherein said error-correcting protocol includes parameters that are set to pre-defined settings based on said negotiated physical layer modulation.

6. A system for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and a answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising:

means for establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

means for establishing said link layer connection based upon said negotiated physical layer modulation.

7. The system of claim **6**, wherein said negotiated physical layer modulation is a fast connect modem modulation.

8. The system of claim **6**, wherein said link layer connection is an error-correcting protocol.

Case 2:07-cv-00439-TJW-CE Document 191-22 Filed 06/28/2007 Page 18 of 18

9. The system of claim **6**, further comprising means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation.

10. A computer program product having a computer readable medium including computer program logic recorded thereon for use in a calling modem for establishing a link layer convention between said calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising:

logic for establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

logic for establishing link layer connection based upon said negotiated physical layer modulation.

* * * * *

Exhibit 4

US005243627A

United States Patent [19]

Betts et al.

[11] Patent Number: 5,243,627

[45] Date of Patent: Sep. 7, 1993

[54] SIGNAL POINT INTERLEAVING TECHNIQUE

[75] Inventors: William L. Betts, St. Petersburg; Edward S. Zuranski, Largo, both of Fla.

[73] Assignee: AT&T Bell Laboratories, Murray Hill, N.J.

[21] Appl. No.: 748,594

[22] Filed: Aug. 22, 1991

[51] Int. Cl.^{5} H04L 5/12

[52] U.S. Cl. 375/39; 375/60; 375/99; 371/43

[58] Field of Search 375/39, 58, 60, 99; 371/43, 37.5, 2.1, 45; 341/81

[56] References Cited

U.S. PATENT DOCUMENTS

3,988,677	10/1976	Fletcher et al.	371/45 X
4,677,624	6/1987	Betts et al.	375/39
4,945,549	7/1990	Simon et al.	375/53
5,029,185	7/1991	Wei	375/39 X

Primary Examiner—Curtis Kuntz
Assistant Examiner—Tesfaldet Bocure
Attorney, Agent, or Firm—Ronald D. Slusky; Gerard A. deBlasi

[57] ABSTRACT

Viterbi decoder performance in a data communication system using 2N-dimensional channel symbols N>1 can be further enhanced by an interleaving technique which uses a distributed trellis encoder in combination with a signal point interleaver.

24 Claims, 4 Drawing Sheets

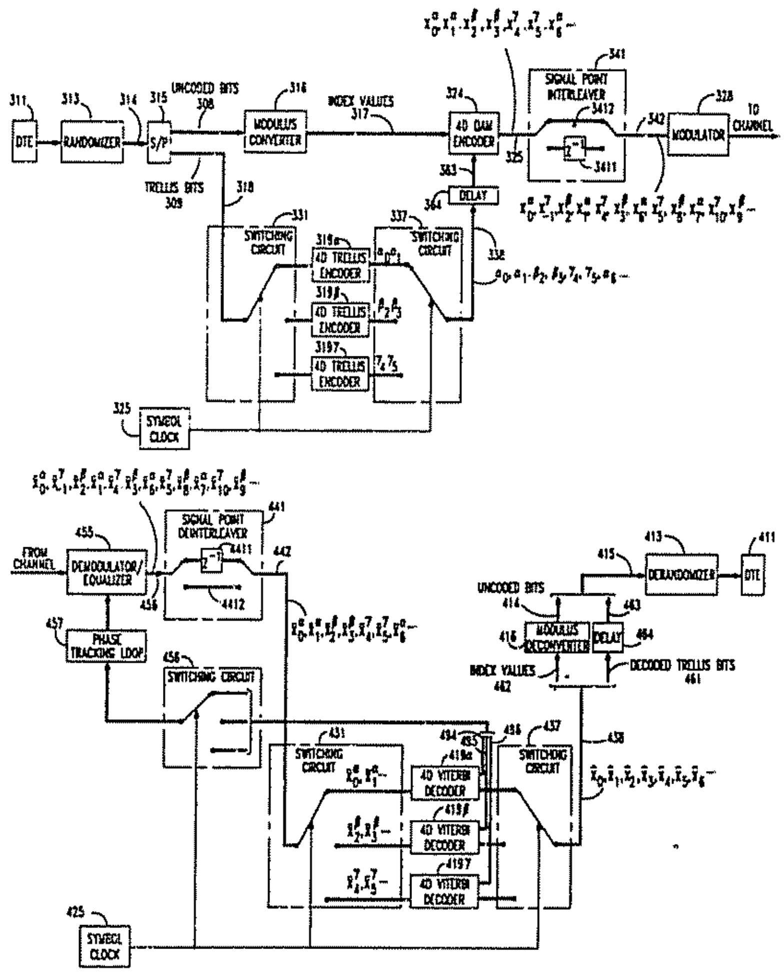


FIG. 1

PRIOR ART

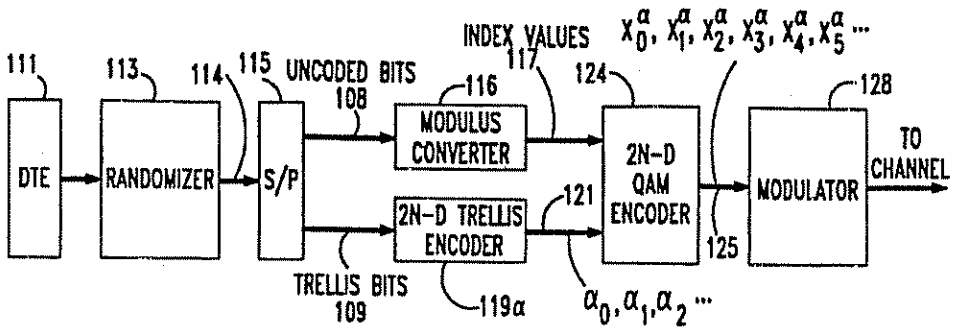
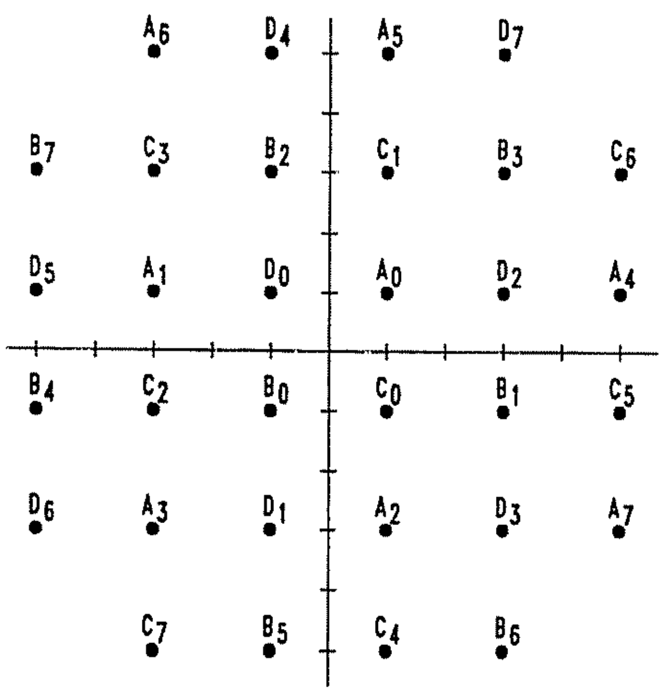


FIG. 2



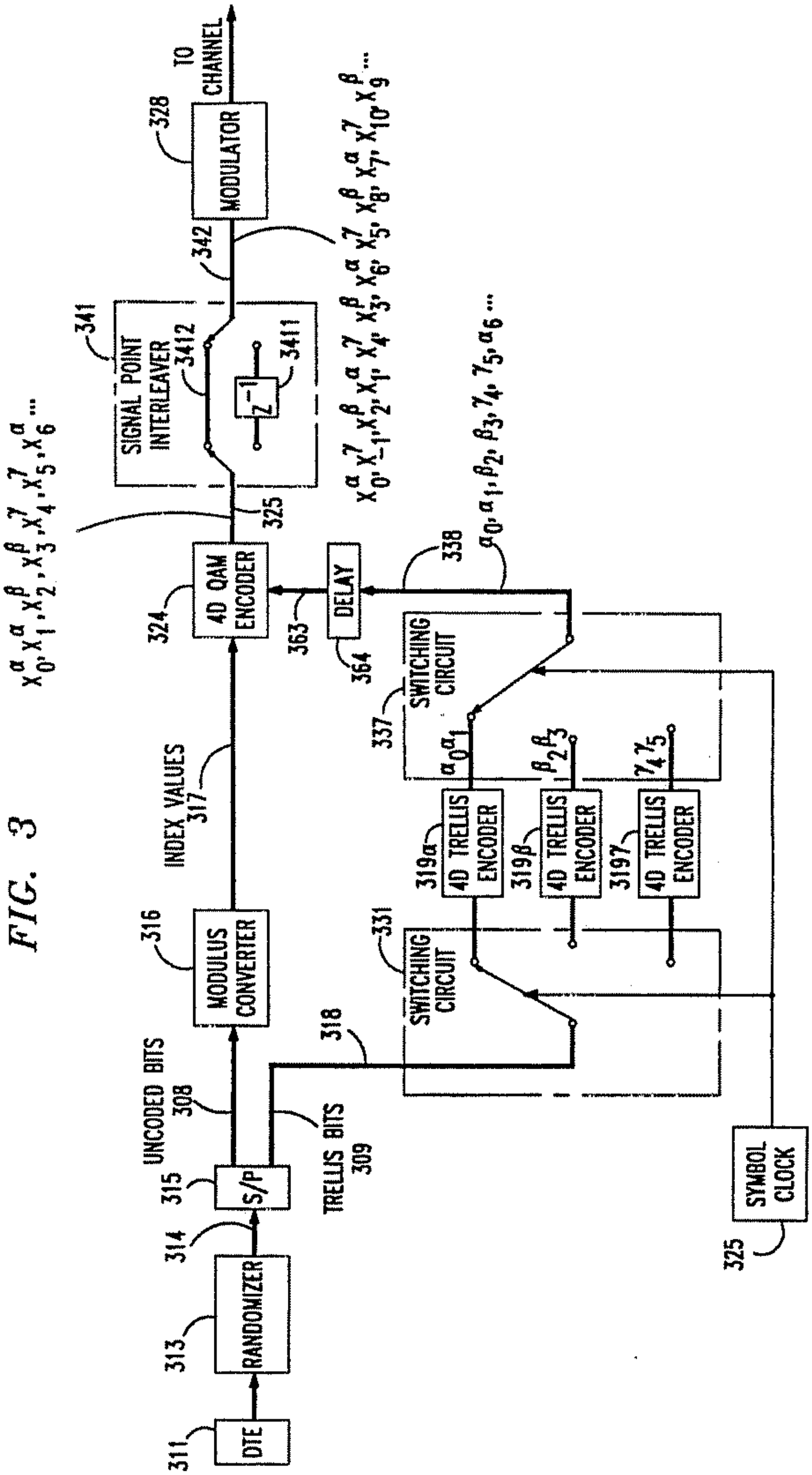

DTE
RANDOMIZER
S/P
UNCODED BITS 308
TRELLIS BITS 309
MODULUS CONVERTER
INDEX VALUES 317
4D QAM ENCODER
SIGNAL POINT INTERLEAVER
MODULATOR
TO CHANNEL
SWITCHING CIRCUIT
4D TRELLIS ENCODER
DELAY
SYMBOL CLOCK
311
313
314
315
316
318
319α
319β
319γ
324
325
328
331
337
338
341
342
363
364
3411
3412

FIG. 3

FIG. 4

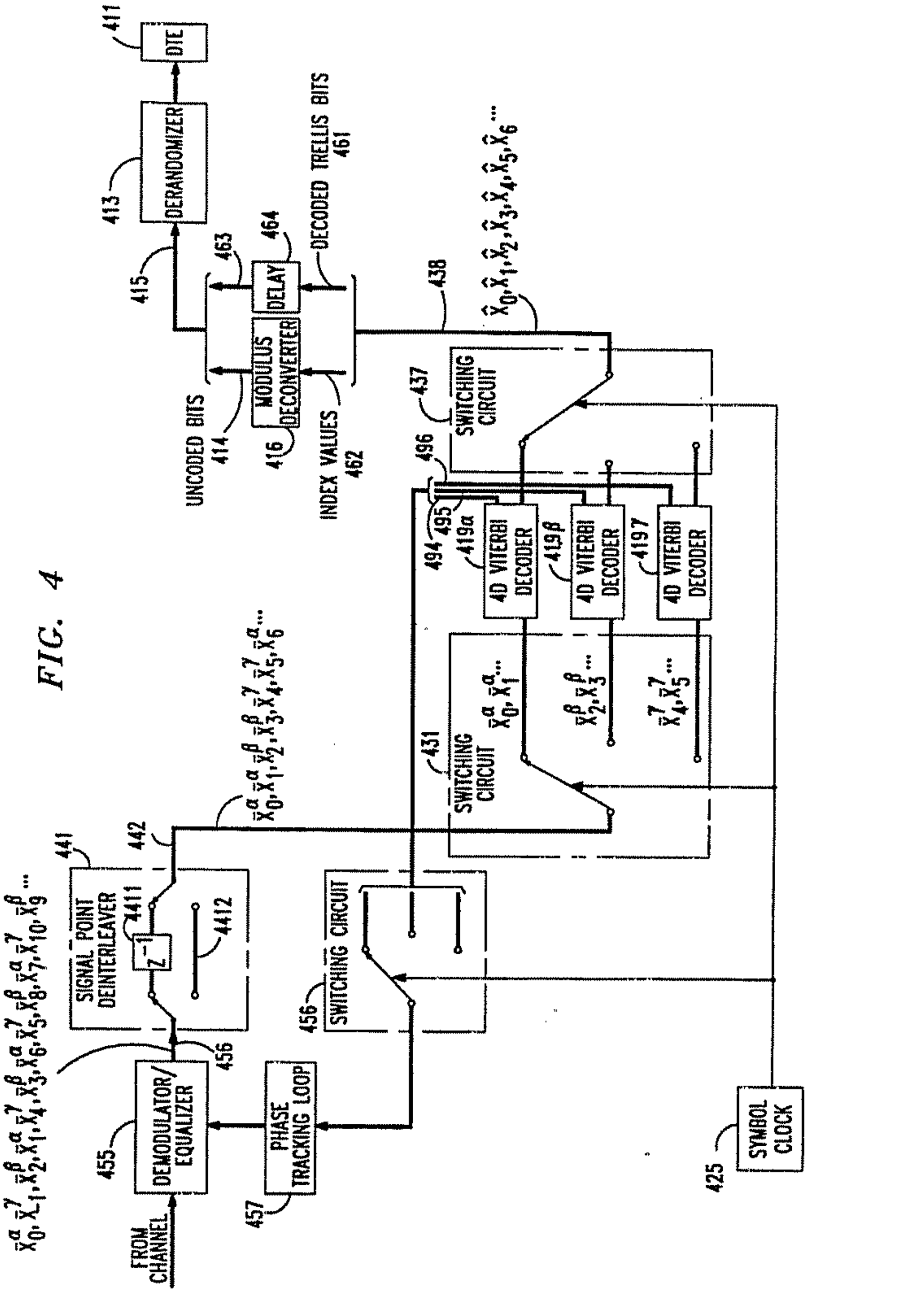

DTE
411
DERANDOMIZER
413
415
463
DELAY
464
DECODED TRELLIS BITS
461
MODULUS DECONVERTER
416
UNCODED BITS
414
INDEX VALUES
462
438
SWITCHING CIRCUIT
437
496
495
494
4D VITERBI DECODER
SWITCHING CIRCUIT
431
SIGNAL POINT DEINTERLEAVER
441
442
4411
4412
456
SWITCHING CIRCUIT
456
DEMODULATOR/ EQUALIZER
455
PHASE TRACKING LOOP
457
FROM CHANNEL
SYMBOL CLOCK
425

FIG. 5

		4D SYMBOL		4D SYMBOL		4D SYMBOL		4D SYMBOL		4D SYMBOL		4D SYMBOL
I	NOT INTERLEAVED ONE TRELLIS STAGE	X_0^α	X_1^α	X_2^α	X_3^α	X_4^α	X_5^α	X_6^α	X_7^α	X_8^α	X_9^α	X_{10}^α ...
II	NOT INTERLEAVED THREE TRELLIS STAGES	X_0^α	X_1^α	X_2^β	X_3^β	X_4^γ	X_5^γ	X_6^α	X_7^α	X_8^β	X_9^β	X_{10}^γ ...
III	INTERLEAVED ONE TRELLIS STAGE	X_0^α	X_{-1}^α	X_2^α	X_1^α	X_4^α	X_3^α	X_6^α	X_5^α	X_8^α	X_7^α	X_{10}^α ...
IV	INTERLEAVED TWO TRELLIS STAGES	X_0^α	X_{-1}^β	X_2^β	X_1^α	X_4^α	X_3^β	X_6^β	X_5^α	X_8^α	X_7^β	X_{10}^β ...
V	INTERLEAVED THREE TRELLIS STAGES	X_0^α	X_{-1}^γ	X_2^β	X_1^α	X_4^γ	X_3^β	X_6^α	X_5^γ	X_8^β	X_7^α	X_{10}^γ ...

FIG. 6

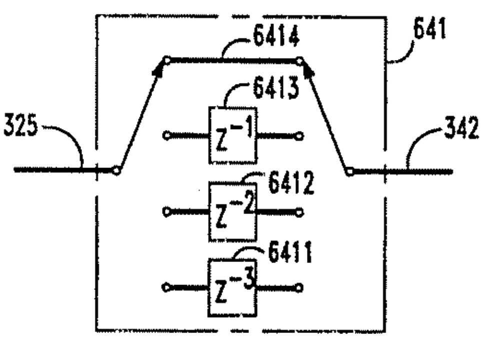
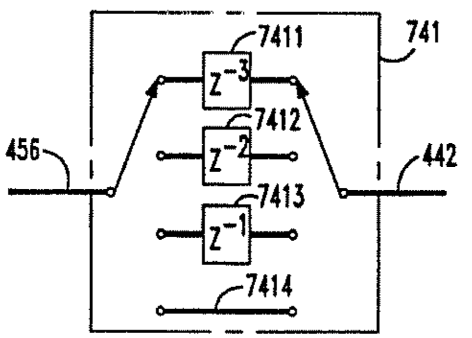


FIG. 7



SIGNAL POINT INTERLEAVING TECHNIQUE

BACKGROUND OF THE INVENTION

The present invention relates to the transmission of digital data over band-limited channels.

Over the years, the requirements of modern-day digital data transmission over band-limited channels—such as voiceband telephone channels—have resulted in a push for higher and higher bit rates. This push has led to the development and introduction of such innovations as adaptive equalization, multi-dimensional signal constellations, echo cancellation (for two-wire applications), and trellis coding. Today, the data rates achieved using these and other techniques are beginning to approach the theoretical limits of the channel.

It has been found that various channel impairments, whose effects on the achievable bit rate were relatively minor compared to, say, additive white Gaussian noise and linear distortion, have now become of greater concern. These include such impairments as nonlinear distortion and residual (i.e., uncompensated-for) phase jitter. Such impairments are particularly irksome in systems which use trellis coding. Indeed, it has been found that the theoretical improvement in Gaussian noise immunity promised by at least some trellis codes is not realized in real-world applications where these impairments are manifest. The principal reason this is so appears to be that the noise components introduced into the received signal samples are such as to worsen the effectiveness of the Viterbi decoder used in the receiver to recover the transmitted data.

U.S. Pat. No. 4,677,625, issued Jun. 30, 1987 to Betts et al, teaches a method and arrangement in which, through the use of a distributed trellis encoder/Viterbi decoder, the effects of many of these impairments can be reduced. The invention in the Betts et al patent recognizes that a part of the reason that the performance of the Viterbi decoder is degraded by these impairments is the fact that the noise components of channel symbols which closely follow one another in the transmission channel are highly correlated for many types of impairments. And it is that correlation which worsens the effect that these impairments have on the Viterbi decoder. Among the impairments whose noise is correlated in this way are impulse noise, phase "hits" and gain "hits." All of these typically extend over a number of adjacent channel symbols in the channel, and thus all result in channel symbol noise components which are highly correlated. The well-known noise enhancement characteristics of linear equalizers also induce correlated noise in adjacent channel symbols, as does uncompensated-for phase jitter. Also, the occurrence of one of the relatively high power points of the signal constellation can, in pulse code modulation (PCM) systems, for example, give rise to noise on adjacent channel symbols which, again, is correlated.

The Betts et al patent addresses this issue by distributing the outgoing data to a plurality of trellis encoders in round-robin fashion and interleaving the trellis encoder outputs on the transmission channel. In the receiver, the stream of received interleaved channel symbols is correspondingly distributed to a plurality of trellis decoders. Since the successive pairs of channel symbols applied to a particular trellis decoder are separated from one another as they traverse the channel, the correlation of the noise components of these channel symbol pairs is reduced from what it would have otherwise been.

SUMMARY OF THE INVENTION

In accordance with the present invention, it has been realized that the Viterbi decoder performance in a data communication system using 2N-dimensional channel symbols can be further enhanced by an interleaving technique which uses, in combination, a) the aforementioned distributed trellis encoder/Viterbi decoder technique and b) a signal point interleaving technique which causes the constituent signal points of the channel symbols to be non-adjacent as they traverse the channel.

In preferred embodiments of the invention, the interleaving is carried out in such a way that every N^{th} signal point in the signal point stream traversing the channel is the N^{th} signal point of a respective one of the channel symbols. This criterion enhances the accuracy with which the phase tracking loop in the receiver performs its function.

Also in preferred embodiments, we have found that the use of three parallel trellis encoders in conjunction with a signal point interleaving regime in which the signal points of each channel symbol are separated from one another by three signaling intervals (bauds) provides an optimum or near-optimum tradeoff between signal point/channel symbol separation and the decoding delay that is caused by the interleaving.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing,

FIG. 1 is a block diagram of the transmitter section of a prior art modem;

FIG. 2 is shows a signal constellation used by the transmitter of FIG. 1;

FIG. 3 is a block diagram of the transmitter section of a modem employing four-dimensional channel symbols and embodying the principles of the invention;

FIG. 4 is a block diagram of the receiver section of a modem embodying the principles of the invention which processes the received four-dimensional channel symbols generated by the transmitter of FIG. 3;

FIG. 5 is a signal point timing/sequencing chart helpful in explaining the principles of the present invention;

FIG. 6 is a signal point interleaver which can be used in the transmitter of FIG. 3 to interleave the signal points of eight-dimensional channel symbols; and

FIG. 7 is a signal point deinterleaver which can be used in the receiver of FIG. 4 to deinterleave the signal points of eight-dimensional channel symbols.

DETAILED DESCRIPTION

FIG. 1 depicts the transmitter section of a prior art modem employing a 2N-dimensional signaling scheme, $N \geqq 1$. The modem receives input information in the form of a serial bit stream from data terminal equipment (DTE) **111**—illustratively a host computer. That bit stream is then scrambled, or randomized, by randomizer **113** whose output bits are provided in serial form to serial-to-parallel (S/P) converter **115**.

Serial-to-parallel converter **115**, in turn, provides, during each of a succession of symbol intervals (comprised of N baud intervals), some predetermined number of parallel bits on lead **109** and some number of parallel bits on lead **108**. (It will be appreciated that whenever bits are provided in parallel in the modem, separate leads are required to carry each of the bits.) The bits on lead **109** are applied to trellis encoder **119a**,

and are referred to as the "trellis bits." The bits on lead **108** are applied to modulus converter **116**, and are referred to as the "uncoded bits."

To better understand how trellis encoder **119**α and modulus converter **116** work, reference is made to FIG. **2**, which shows the two-dimensional signal constellation that forms the basis of the 2N-dimensional signaling scheme illustratively used by the modem. This constellation is comprised of 32 signal points, which are divided into four subsets, A through D, each comprised of eight signal points. The eight points of subset A are explicitly labeled as A_0 through A_7. It may be noted that subsets C, B and D can be arrived at by clockwise rotation of subset A by 90, 180 and 270 degrees, respectively. (Conventional differential encoding circuitry within trellis encoder **119**α exploits this symmetry.) For reference, a single signal point of each of those subsets is also shown on FIG. **2**.

Consider, first, the case of N=1, i.e., a two-dimensional signaling scheme. In this case, one trellis bit on lead **109** would be expanded to two bits by trellis encoder **119**α on lead **121**. The four possible values of those three bits 00, 01, 10, and 11 identify subsets A, B, C and D, respectively. The successive 2-bit words on lead **121** are represented as α_n, n=0,1,2. . . , where n is an index that advances at the baud rate. At the same time, three parallel bits would be provided on lead **108**. These are converted by modulus converter **116** into an index having a value within the range (decimal) 0 to 7. The index value, represented in binary form on lead **117**, selects a particular signal point from the subset identified on lead **121**. Thus if lead **121** carries the two bits **00** while lead **117** carries the three bits **001**, then signal point A_1 of the FIG. **2** constellation has been selected. The words on leads **117** and **121** are applied to QAM encoder **124** which generates, on lead **125**, values representing the I (in-phase) and Q (quadrature-phase) components of signal point A_1. The signal point generated on lead **125** in the n^{th} baud interval is denoted X_n^{α}, which is passed on to modulator **128** to generate a passband line signal which is applied to the communication channel. The superscript, α, indicates that the trellis encoder that was used to identify the subset for any particular signal point was trellis encoder **119**α. That is, of course, a trivial notation as far as FIG. **1** goes inasmuch as trellis encoder **119**α is the only trellis encoder in the modem. However, it is useful to introduce this notation because more than one trellis encoder stage is used in preferred embodiments of modems incorporating the principles of the present invention as shown in later FIGS.

In the case of N>1, the operation is similar. Now, however, the words on lead **109** are used by trellis encoder **119**α to sequentially identify on lead **121**N subsets, while the words on lead **108** are used to generate N corresponding index values on lead **117**. The N signal points identified in this way are the component signal points of a 2N-dimensional channel symbol, the first such symbol being comprised of the signal points X_0^{α}, . . . $X_{(N-1)}^{\alpha}$. For example, a modem in which the transmitter of FIG. **1** could be used may be a 14,400 bit per second modem using four-dimensional coding (i.e., N=2) and a baud rate of 3200. In this case, nine bits from S/P converter **115** are used for each four-dimensional symbol. Specifically, three parallel bits on lead **109** are expanded into four bits on lead **121** to identify a pair of subsets while six bits on lead **108** are used to select particular signal points from those two subsets. Those two signal points are thereupon communicated over the channel by QAM encoder **124** and modulator **128** as described above.

Note that, implementationally, the 2N-dimensional channel symbol is generated by having the trellis encoder identify, interdependently, N subsets of the two-dimensional constellation of FIG. **2**, then select a two-dimensional signal point from each of the subsets thus identified. The concatenation of the N two-dimensional signal points thus selected is the desired 2N-dimensional channel symbol. This process, however, can be understood as involving the direct selection of a 2N-dimensional channel symbol. Viewed in this context, the set of all possible combinations of N of the two-dimensional subsets identified by N successive trellis encoder outputs can be understood to be a set of 2N-dimensional subsets of a 2N-dimensional constellation, the latter being comprised of all possible combinations of N of the signal points of the two-dimensional constellation. A succession of N outputs from the trellis encoder identifies a particular one of the 2N-dimensional subsets and a succession of N outputs from the modulus converter selects a particular 2N-dimensional signal point from the identified 2N-dimensional subset.

Modulus converter **116** is illustratively of the type disclosed in co-pending, commonly-assigned U.S. patent application Ser. No. 588,658 filed Sep. 26, 1990 and allowed on May 21, 1991, hereby incorporated by reference. Modulus converter **116** provides the modem with the ability to support data transmission at various different bit rates. Assume, for example, that the rate at which bits are provided by DTE **111** decreases. The serial-to-parallel converter will continue to provide its outputs on leads **108** and **109** at the same baud rate as before. However, the upper limit of the range of index values that are provided by modulus converter **116** on lead **117** will be reduced, so that, effectively, each of the four subsets A through D, instead of having eight signal points, will have some smaller number. Conversely if the rate at which bits are provided by DTE **111** should increase over that originally assumed, the upper limit of the range of index values, and thus the number of parallel bits, that appear on lead **117** will be increased beyond eight and the constellation itself will be expanded to accommodate the larger number of signal points thus being selected. As an alternative to using a modulus converter, fractional bit rates can be supported using, for example, the technique disclosed in L. Wei, "Trellis-Coded Modulation with Multidimensional Constellations," *IEEE Trans. on Communication Theory*, Vol. IT-33, No. 4, July 1987, pp. 483-501.

Turning now to FIG. **3**, the transmitter portion of a modem embodying the principles of the invention is shown. This embodiment illustratively uses the aforementioned four-dimensional, i.e., N=2, signaling scheme. Many of the components are similar to those shown in FIG. **1**. Thus, in particular, the transmitter of FIG. **3**—which receives its input information in the form of a stream of input bits from DTE **311**—includes randomizer **313**, which supplies its output, on lead **314**, to S/P converter **315**. The latter outputs uncoded bits to modulus converter **316**. The transmitter further includes four-dimensional QAM encoder **324** and modulator **328**. The trellis bits, on lead **309**, are provided not to a standard single trellis encoder, but to a distributed trellis encoder comprised of three trellis encoder stages: trellis encoder stage **319**α, trellis encoder stage **319**β, and trellis encoder stage **319**γ.

Such a distributed trellis encoder, which is described in the aforementioned Betts et al patent, generates a plurality of streams of trellis encoded channel symbols in response to respective portions of the input information. Specifically, a three-bit word on lead **309** is supplied to trellis encoder stage **319**α. The next three-bit word on lead **309** is supplied to trellis encoder stage **319**β. The next three-bit word is supplied to trellis encoder stage **319**γ, and then back to trellis encoder stage **319**α. This distribution of the trellis bits to the various trellis encoder stages is performed by switching circuit **331** operating under the control of symbol clock **325**. The initial data word outputs of the trellis encoders are subset identifiers α_0 and α_1 for encoder stage **319**α, β_2 and β_3 for encoder stage **319**β, and γ_4 and γ_5 for encoder stage **319**γ, followed by α_6 and α_7 for encoder stage **319**α, and so forth. These are supplied to four-dimensional QAM encoder **324** by switching circuit **337**—also operating under the control of symbol clock **325**—on lead **338** through a one-symbol delay **364** and lead **363**, in order to compensate for a one-symbol delay caused by modulus converter **316**. Thus, the stream of subset identifiers on lead **338** is α_0, α_1, β_2, β_3, γ_4, γ_5, α_6 . . . . Using the notation introduced above, then, the output of encoder **324** on lead **325** is the stream of signal points X_0^α, X_1^α, X_2^β, X_3^β, X_4^γ, X_5^γ, X_6^α . . . , which is comprised of three interleaved streams of trellis encoded channel symbols, these streams being X_0^α, X_1^α, X_6^α, X_7^α, X_{12}^α . . . ; X_2^β, X_3^β, X_8^β, X_9^β, X_{14}^β . . . ; and X_4^γ, X_5^γ, X_{10}^γ, X_{11}^γ, X_{16}^γ . . . . These, in turn, are supplied, in accordance with the invention, to signal point interleaver **341** which applies alternate ones of the signal points applied thereto to lead **3412**—which signal points appear immediately at the interleaver output on lead **342**—and to one-symbol (Z^{-1}) delay element **3411**, which appear on lead **342** after being delayed therein by one symbol interval. The resulting interleaved stream of trellis encoded signal points is X_0^α, X_{-1}^γ, X_2^β, X_1^α, X_4^γ, X_3^β, X_6^α, X_5^γ, X_8^β, X_7^α, X_{10}^γ, X_9^β . . . (the signal point X_{-1}^γ being, of course, the signal point applied to interleaver **341** just ahead of signal point X_0^α).

A discussion and explanation of how the interleaving just described is advantageous is set forth hereinbelow. In order to fully set the stage for that explanation, however, it will be first useful to consider the receiver section of a modem which receives the interleaved signal point stream.

Thus referring to FIG. **4**, the line signal transmitted by the transmitter of FIG. **3** is received from the channel and applied to demodulator/equalizer **455** which, in conventional fashion—including an input from phase tracking loop **457**—generates a stream of outputs on lead **456** representing the demodulator/equalizer's best approximation of the values of the I and Q components of the signal points of the transmitted interleaved signal point stream. These outputs are referred to herein as the "received signal points." (Due to distortion and other channel impairments that the demodulator/equalizer is not able to compensate for, the I and Q components of the received signal points, instead of having exact integer values, can have any value. Thus a transmitted signal point having coordinates (3, −5) may be output by the demodulator/equalizer as the received signal point (2.945, −5.001).) The stream of received signal points on lead **456** is denoted $\bar{X}_0^\alpha$, $\bar{X}_{-1}^\gamma$, $\bar{X}_2^\beta$, $\bar{X}_1^\alpha$, $\bar{X}_4^\gamma$, $\bar{X}_3^\beta$, $\bar{X}_6^\alpha$, $\bar{X}_5^\gamma$, $\bar{X}_8^\beta$, $\bar{X}_7^\alpha$, $\bar{X}_{10}^\gamma$, $\bar{X}_9^\beta$ . . . .

The successive received signal points are deinterleaved in signal point deinterleaver **441**, which provides the opposite function to interleaver **341** in the transmitter. The output of deinterleaver **441** on lead **442** is thus $\bar{X}_0^\alpha$, $\bar{X}_1^\alpha$, $\bar{X}_2^\beta$, $\bar{X}_3^\beta$, $\bar{X}_4^\gamma$, $\bar{X}_5^\gamma$, $\bar{X}_6^\alpha$, . . . , etc. (Although not explicitly shown in the drawing, the same well-known techniques used in modems of this general kind to identify within the stream of received signal points the boundaries between successive symbols is used to synchronize the operation of signal point deinterleaver **441** to ensure that received signal points $\bar{X}_0^\alpha$, $\bar{X}_2^\beta$, $\bar{X}_4^\gamma$ . . . are applied to delay element **4411** while received signal points $\bar{X}_1^\alpha$, $\bar{X}_3^\beta$, $\bar{X}_5^\gamma$ . . . are applied to lead **4412**.)

The received signal points on lead **442** are then distributed by switching circuit **431** under the control of symbol clock **425** to a distributed Viterbi decoder comprised of 4D Viterbi decoder stages **419**α, **419**β and **419**γ. Specifically, received signal points $\bar{X}_0^\alpha$ and $\bar{X}_1^\alpha$ are applied to decoder stage **419**α; received signal points $\bar{X}_2^\beta$ and $\bar{X}_3^\beta$ are applied to decoder stage **419**β; and received signal points $\bar{X}_4^\gamma$ and $\bar{X}_5^\gamma$ are applied to decoder stage **419**γ. The outputs of the three decoder stages are then combined into a serial stream on lead **438** by switching circuit **437**, also operating under the control of symbol clock **425**. Those outputs, representing decisions as to the values of the transmitted signal points, are denoted $\hat{X}_0$, $\hat{X}_1$, $\hat{X}_2$, $\hat{X}_3$, $\hat{X}_4$, $\hat{X}_5$, $\hat{X}_6$, . . . , the α, β and γ superscripts no longer being needed.

In conventional fashion, the bits that represent each of the decisions on lead **438** can be divided into bits that represent a) the trellis bits that appeared on transmitter lead **309** and b) the index values that appeared on transmitter lead **317**. Those two groups of bits are provided in the receiver on leads **461** and **462**, respectively. The latter group of bits are deconverted by modulus deconverter **416** (also disclosed in the aforementioned '658 patent application) back to uncoded bit values on lead **414**. The operation of the modulus deconverter imparts a one-symbol delay to the bits on lead **414**. Accordingly, the bits on lead **461** are caused to be delayed by one symbol by delay element **464**. The resulting combined bits on lead **415** thus represent the stream of bits that appeared at the output of randomizer **313** in the transmitter. These are derandomized in the receiver by derandomizer **413** and the resulting derandomized bit stream is applied to DTE **411** which may be, for example, a computer terminal.

Referring to FIG. **5**, one can see the improvement that is achieved by the present invention.

Line I shows the stream of output signal points generated and launched into the channel using one stage of trellis encoding and no signal point interleaving. This is, of course, the prior art arrangement shown in FIG. **1**. Line II shows the effect of providing a three-stage distributed trellis encoder but still no signal point interleaving. This is the arrangement shown in the aforementioned Betts et al patent. Note that the signal points of each channel symbol operated on by a particular trellis encoder stage are adjacent in the output signal point stream. For example, the second signal point of the symbol X_0^α X_1^α—namely signal point X_1^α—is separated by five baud intervals from the first (closer) signal point of the symbol X_6^α X_7^α—namely signal point X_6^α. As noted earlier, such separation is advantageous because the channel symbols which are processed one after the other in a particular Viterbi decoder stage have noise components which are not highly correlated.

Note, however, that the individual signal points of each channel symbol, e.g., X_0^α and X_1^α, are adjacent to

one another as they pass through the channel; and since all the signal points of a channel symbol must be processed serially in the same Viterbi decoder stage, this means that the Viterbi decoder must process adjacent signal points that have highly correlated noise components.

It is to this end that signal point interleaver **341** is included within the transmitter in accordance with the invention. Firstly, it may be noted from Line III that using the signal point interleaver without the distributed trellis encoder—an arrangement not depicted in the drawing—will, advantageously, cause the signal points from the same channel symbol to be non-adjacent. Moreover, there is further advantage in that a pair of channel symbols processed serially by Viterbi decoder stage **419**α traverses the channel separated by five baud intervals rather than three, thereby providing greater decorrelation of the noise components thereof. Compare, for example, the span of baud intervals occupied by signal points X_0^α and X_1^α, X_2^α and X_3^α in Line I and the span of baud intervals occupied by the same signal points in Line III. Disadvantageously, however, the use of a single trellis encoding stage brings back the problem that the distributed trellis encoder solves, as described above. Thus, for example, although signal points X_0^α and X_1^α, which are from the same channel symbol, are separated from one another when traversing the channel, we find that, disadvantageously, signal points X_2^α and X_1^α, which are signal points from two different channel symbols which will be processed serially by the Viterbi decoder, traverse the channel adjacent to one another.

Line IV shows that using the signal point interleaver with a two-stage trellis encoder—also an arrangement not depicted in the drawing—provides some improvement. Firstly, it may be noted that, as in Line III, signal points from the same channel symbol remain separated by three baud intervals. Additionally, pairs of channel symbols processed sequentially by a given Viterbi decoder stage—such as the channel symbols comprised of signal points X_0^α and X_1^α, X_4^α and X_5^α—are still non-adjacent and, indeed, are now separated by seven baud intervals, which is even greater than the separation of five baud intervals provided in Line III. Moreover, certain signal points that traverse the channel adjacent to one another and which are from channel symbols which would have been decoded sequentially in the one-trellis-encoding-stage case are, in the two-trellis-encoding-stage case of Line IV, processed by different Viterbi decoding stages. Signal points X_2^β and X_1^α are such a pair of signal points. Note, however, that, disadvantageously, signal points X_1^α and X_4^α traverse the channel serially, and are from channel symbols which are serially processed by the "α" Viterbi decoder stage.

Referring, however, to Line V, which depicts the stream of signal points output by the transmitter of FIG. 3, it will be seen that, in accordance with the invention, there is still a non-adjacency—indeed, a separation of at least three baud intervals—between a) the signal points which belong to any particular channel symbol (and which, therefore, are processed serially by a particular Viterbi decoder stage) and b) the signal points which belong to channel symbols which are processed serially by a Viterbi decoder stage. Thus, for example, signal points X_1^α and X_4^γ are now processed by different Viterbi decoder stages. Moreover, pairs of channel symbols processed sequentially by a given Viterbi decoder stage—such as the channel symbols comprised of signal points X_0^α and X_1^α, X_6^α and X_7^α—are now separated by none baud intervals.

Using more than three trellis encoder stages in the distributed trellis encoder and/or a signal point interleaver that separates signal points from the same channel symbol by more than three baud intervals would provide even greater separation and could, therefore, potentially provide even greater improvement in Viterbi decoding. However, such improvement comes at a price—that price being increased decoding delay—particularly as the number of trellis encoders is increased beyond three. An engineering trade-off can be made, as suits any particular application.

Moreover, it is desirable for the signal point interleaver to provide a sequence in which every N^{th} signal point in the interleaved signal point stream is the N^{th} signal point of a channel symbol. (The reason this is desirable is described in detail hereinbelow.) In the case of an N=2, four-dimensional signaling scheme, this means that every second, that is "every other," signal point in the interleaved stream is the second signal point of the channel symbol from which it comes. In the case of an N=4, eight-dimensional signaling scheme, this means that every fourth signal point in the interleaved stream is the fourth signal point of the channel symbol from which it comes. Indeed, this criterion is in fact satisfied in the embodiment of FIG. 3. Note that each one of signal points X_0^α, X_2^β, X_4^γ, X_6^α, . . . , which appear as every other signal point in the interleaved stream, is the second signal point of one of the four-dimensional channel symbols. Note that not all rearrangements of the signal points will, in fact, satisfy this criterion, such as, if the two signal points of a channel symbol are separated by two, rather than three, baud intervals.

Satisfying the above criterion is advantageous because it enhances the accuracy with which phase tracking loop **457** performs its function. This is so because the arrival of an N^{th} signal point of a given symbol means that all the signal points comprising that channel symbol have arrived. This, in turn, makes it possible to form a decision as to the identity of that channel symbol by using the minimum accumulated path metric in the Viterbi decoder stages. (Those decisions are fed back to the tracking loop by decoder stages **419**α, **419**β **419**γ on leads **494**, **495** and **496**, respectively, via switching circuit **456**.) Without having received all of the signal points of a channel symbol, one cannot take advantage of the accumulated path metric information but, rather, must rely on the so-called raw sliced values, which is less accurate. By having every N^{th} signal point in the interleaved stream be the N^{th} signal point of a channel symbol, we are guaranteed that the time between adjacent such path metric "decisions" supplied to the phase tracking loop is, advantageously, never more than N baud intervals.

The foregoing merely illustrates the principles of the invention. Thus although the illustrative embodiment utilizes a four-dimensional signaling scheme, the invention can be used with signaling schemes of any dimensionality. In the general, 2N-dimensional, case each stage of the distributed trellis encoder would provide N two-dimensional subset identifiers to switching circuit **337** before the latter moves on to the next stage. And, of course, each stage of the distributed Viterbi decoder would receive N successive received signal points. The distributed trellis encoder and distributed Viterbi decoder can, however, continue to include three trellis

encoders and still maintain, independent of the value of N, a separation of three baud intervals in the channel between signal points that are from channel symbols that are adjacent in the trellis encoder. If a greater separation of such signal points is desired, more stages can be added to the distributed trellis encoder/Viterbi decoder, just as was noted above for the four-dimensional case. However, when dealing with 2N-dimensional signaling where $N>2$, it is necessary to add additional delay elements to the signal point interleaver/deinterleaver in order to maintain a three-baud-interval separation among the signal points from any given channel symbol.

Consider, for example, the case of $N=4$, i.e., an eight-dimensional case. Looking again at FIG. 3, the three (8D) stages of the distributed trellis encoder would generate the three streams of subset identifiers $\alpha_0\,\alpha_1\,\alpha_2\,\alpha_3\,\alpha_{12}\ldots$, $\beta_4\,\beta_5\,\beta_6\,\beta_7\,\beta_{16}\ldots$, and $\gamma_8\,\gamma_9\,\gamma_{10}\,\gamma_{11}\,\gamma_{20}\ldots$, respectively. This would lead to the following stream of signal points of eight-dimensional trellis encoded channel symbols at the output of the QAM encoder on lead **325**: $X_0^\alpha\ X_1^\alpha\ X_2^\alpha\ X_3^\alpha\ X_4^\beta\ X_5^\beta\ X_6^\beta\ X_7^\beta\ X_8^\gamma\ X_9^\gamma X_{10}^\gamma\ X_{11}^\gamma\ X_{12}^\alpha\ldots$ Signal point interleaving could be carried out by substituting signal point interleaver **641** of FIG. **6** for interleaver **341**. Interleaver **641**, in addition to direct connection **6414**, includes one-, two-, and three-symbol delay elements **6413**, **6412** and **6411**, respectively.

The signal points on lead **325**, after passing through interleaver **641**, would appear on lead **342** in the following order: $X_0^\alpha\ X_{-3}^\gamma\ X_{-6}^\beta\ X_{-9}^\alpha\ X_4^\beta\ X_1^\alpha\ X_{-2}^\gamma\ X_{-5}^\beta\ X_8^\gamma\ X_5^\beta\ X_2^\alpha\ X_{-1}^\gamma\ X_{12}^\alpha\ X_9^\gamma\ X_6^\beta\ X_3^\alpha\ X_{16}^\beta\ X_{13}^\alpha\ X_{10}^\gamma\ X_7^\beta\ldots$ where signal points with negative subscripts are, of course, signal points that arrived before signal point X_0^α and were already stored in the delay elements **6411**, **6412** and **6413**. Examination of this signal point stream will reveal that there is either a three- or five-baud separation between signal points of channel symbols that are processed sequentially by the same trellis encoder stage, e.g., X_3^α and X_{12}^α; that adjacent signal points of any one channel symbol, e.g., X_0^α and X_1^α, are separated by five baud intervals; and that the four signal points comprising any particular one channel symbol are separated by fifteen baud intervals.

FIG. 7 shows the structure of a deinterleaver **741** that could be used in the receiver of FIG. 4 in place of deinterleaver **441** in order to restore the signal points of the eight-dimensional channel symbols to their original order. This structure, which is the inverse of interleaver **641**, includes delay stages **7411**, **7412** and **7413**, as well as direct connection **7414**.

It will be appreciated that, although various components of the modem transmitter and receiver are disclosed herein for pedagogic clarity as discrete functional elements and indeed—in the case of the various switching circuits—as mechanical elements, those skilled in the art will recognize that the function of any one or more of those elements could be implemented with any appropriate available technology, including one or more appropriately programmed processors, digital signal processing (DSP) chips, etc. For example, multiple trellis encoders and decoders can be realized using a single program routine which, through the mechanism of indirect addressing of multiple arrays within memory, serves to provide the function of each of the multiple devices.

It will thus be appreciated that those skilled in the art will be able to devise numerous arrangements which, although not explicitly shown or described herein, embody the principles of the invention and are within its spirit and scope.

We claim:

1. Apparatus for forming a stream of trellis encoded signal points in response to input information, said apparatus comprising

means for generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points, and

means for interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points.

2. The apparatus of claim **1** wherein said means for generating generates three of said streams of trellis encoded channel symbols, and wherein said means for interleaving causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

3. The apparatus of claim **1** wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

4. The apparatus of claim **2** wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

5. A modem comprising

means for receiving a stream of input bits,

means for dividing said stream of input bits into a stream of uncoded bits and a plurality of streams of trellis bits,

means for independently trellis encoding each of said plurality of streams of trellis bits to generate respective streams of data words each identifying one of a plurality of predetermined subsets of the channel symbols of a predetermined 2N-dimensional constellation, N being an integer greater than unity, each of said channel symbols being comprised of a plurality of signal points,

means for selecting an individual channel symbol from each identified subset in response to said stream of uncoded bits to form a stream of channel symbols, and

means for generating a stream of output signal points, said signal point stream being comprised of the signal points of the selected channel symbols, the signal points of said signal point stream being sequenced in such a way that signal points that are either a) part of the same channel symbol, or b) part of channel symbols that are adjacent to one another in said channel symbol stream, are separated in said output stream by at least one other signal point.

6. The apparatus of claim **5** wherein said trellis encoding means includes a plurality of trellis encoder stage

means for trellis encoding respective ones of said streams of trellis bits.

7. The apparatus of claim 5 wherein said means for selecting includes means for modulus converting said stream of uncoded bits.

8. The apparatus of claim 5 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said means for generating causes every N^{th} signal point in said stream of output signal points to be the N^{th} signal point of a respective one of said channel symbols.

9. Receiver apparatus for recovering information from a received stream of trellis encoded signal points, said signal points having been transmitted to said receiver apparatus by transmitter apparatus which generates said signal points by generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information, each of said channel symbols being comprised of a plurality of signal points, and by interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

said receiver apparatus comprising

means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.

10. The apparatus of claim 9 further comprising

a phase tracking loop, and

means for adapting the operation of said phase tracking loop in response to minimum accumulated path metrics in said distributed Viterbi decoder.

11. A method for forming a stream of trellis encoded signal points in response to input information, said method comprising the steps of

generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points, and

interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points.

12. The method of claim 11 wherein said generating step generates three of said streams of trellis encoded channel symbols, and wherein said interleaving step causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

13. The method of claim 11 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said interleaving step causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

14. The method of claim 12 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said interleaving step causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

15. A method for use in a modem, said method comprising the steps of

receiving a stream of input bits,

dividing said stream of input bits into a stream of uncoded bits and a plurality of streams of trellis bits,

independently trellis encoding each of said plurality of streams of trellis bits to generate respective streams of data words each identifying one of a plurality of predetermined subsets of the channel symbols of a predetermined 2N-dimensional constellation, N being an integer greater than unity, each of said channel symbols being comprised of a plurality of signal points,

selecting an individual channel symbol from each identified subset in response to said stream of uncoded bits to form a stream of channel symbols, and

generating a stream of output signal points, said signal point stream being comprised of the signal points of the selected channel symbols, the signal points of said signal point stream being sequenced in such a way that signal points that are either a) part of the same channel symbol, or b) part of channel symbols that are adjacent to one another in said channel symbol stream, are separated in said output stream by at least one other signal point.

16. The method of claim 15 wherein in said trellis encoding step a plurality of trellis encoder stages trellis encode respective ones of said streams of trellis bits.

17. The method of claim 15 wherein said selecting step includes the step of modulus converting said stream of uncoded bits.

18. The method of claim 15 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said generating step causes every N^{th} signal point in said stream of output signal points to be the N^{th} signal point of a respective one of said channel symbols.

19. A method for use in a receiver to recover information from a received stream of trellis encoded signal points, said signal points having been transmitted to said receiver apparatus by a method which includes the steps of

generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information, each of said channel symbols being comprised of a plurality of signal points, and

interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

said method comprising the steps of

deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

using a distributed Viterbi decoder to recover said information from the deinterleaved signal points.

20. The method of claim 19 wherein said receiver includes a phase tracking loop and wherein said method comprises the further step of adapting the operation of said phase tracking loop in response to minimum accumulated path metrics in said distributed Viterbi decoder.

21. Data communication apparatus comprising

means for receiving input information,

means for generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points,

means for interleaving the signal points of said generated channel symbols to form a stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

means for applying the stream of trellis encoded signal points to a transmission channel,

means for receiving the stream of trellis encoded signal points from the channel,

means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.

22. The apparatus of claim 21 wherein said means for generating generates three of said streams of trellis encoded channel symbols, and wherein said means for interleaving causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

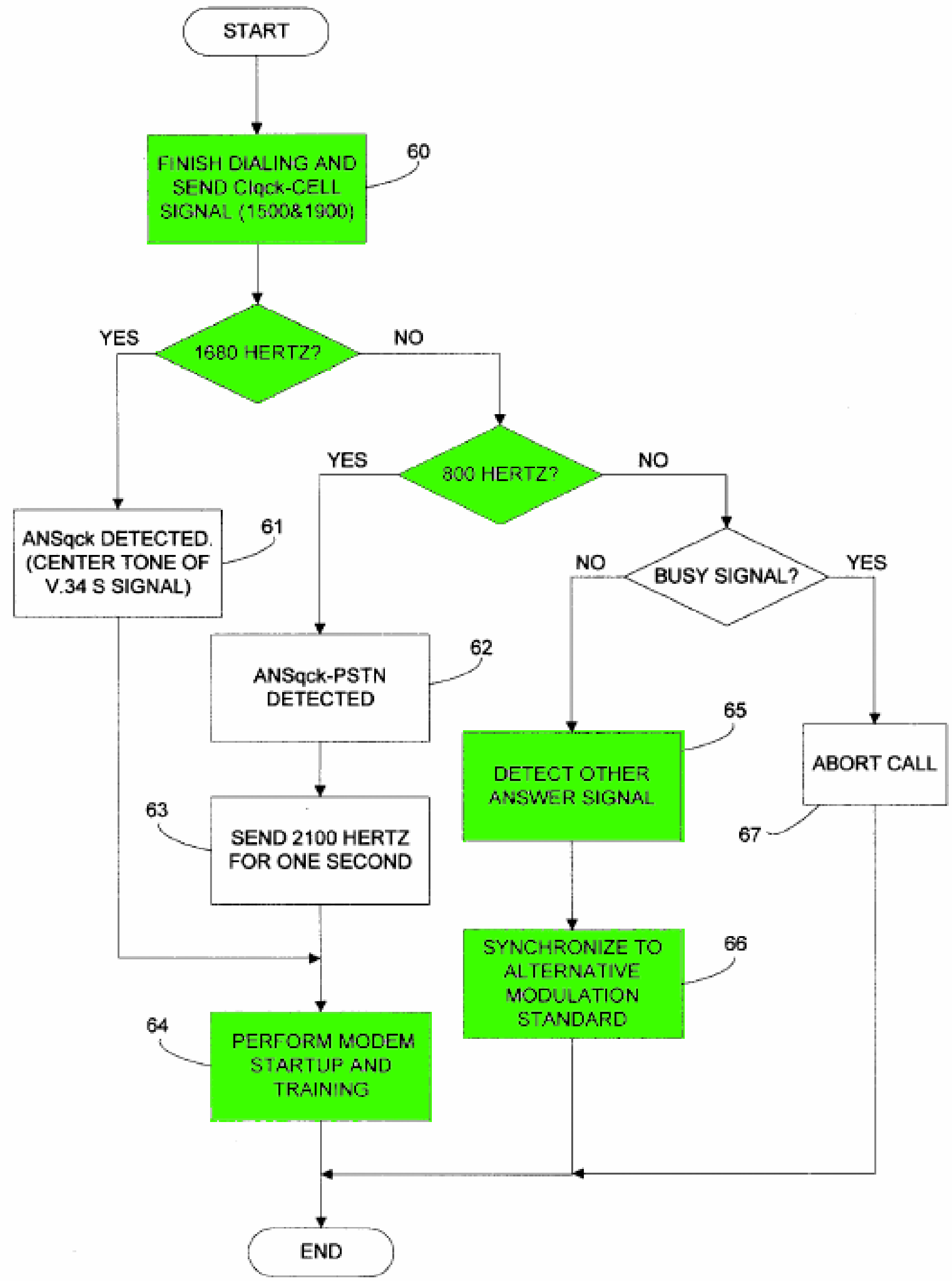
23. The apparatus of claim 21 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

24. The apparatus of claim 22 wherein said channel symbols are 2N-dimensional channel symbols, $N>1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

* * * * *

<u>Exhibit 5</u>

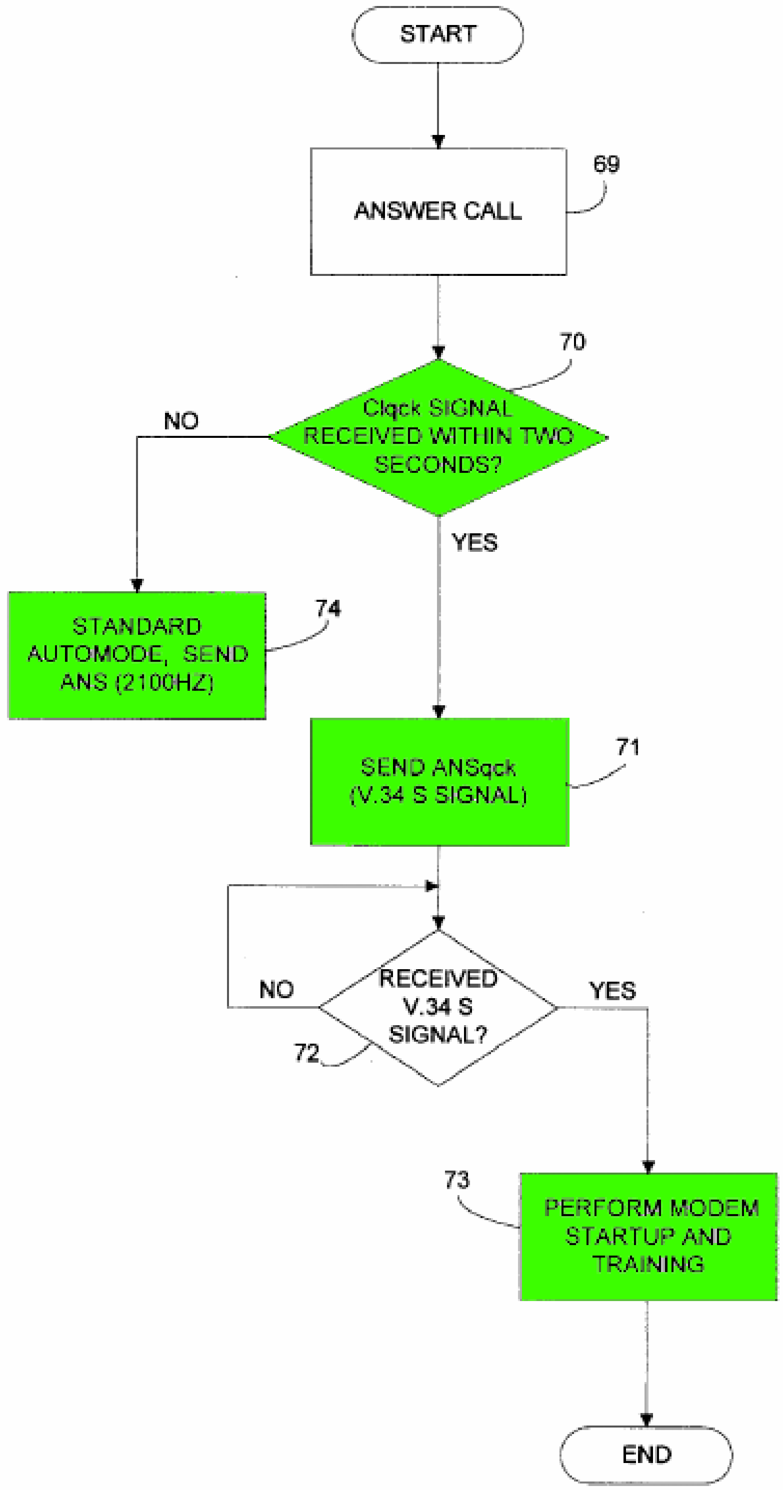
EXHIBIT 5-A



Calling Modem -- Cellular

FIG. 4

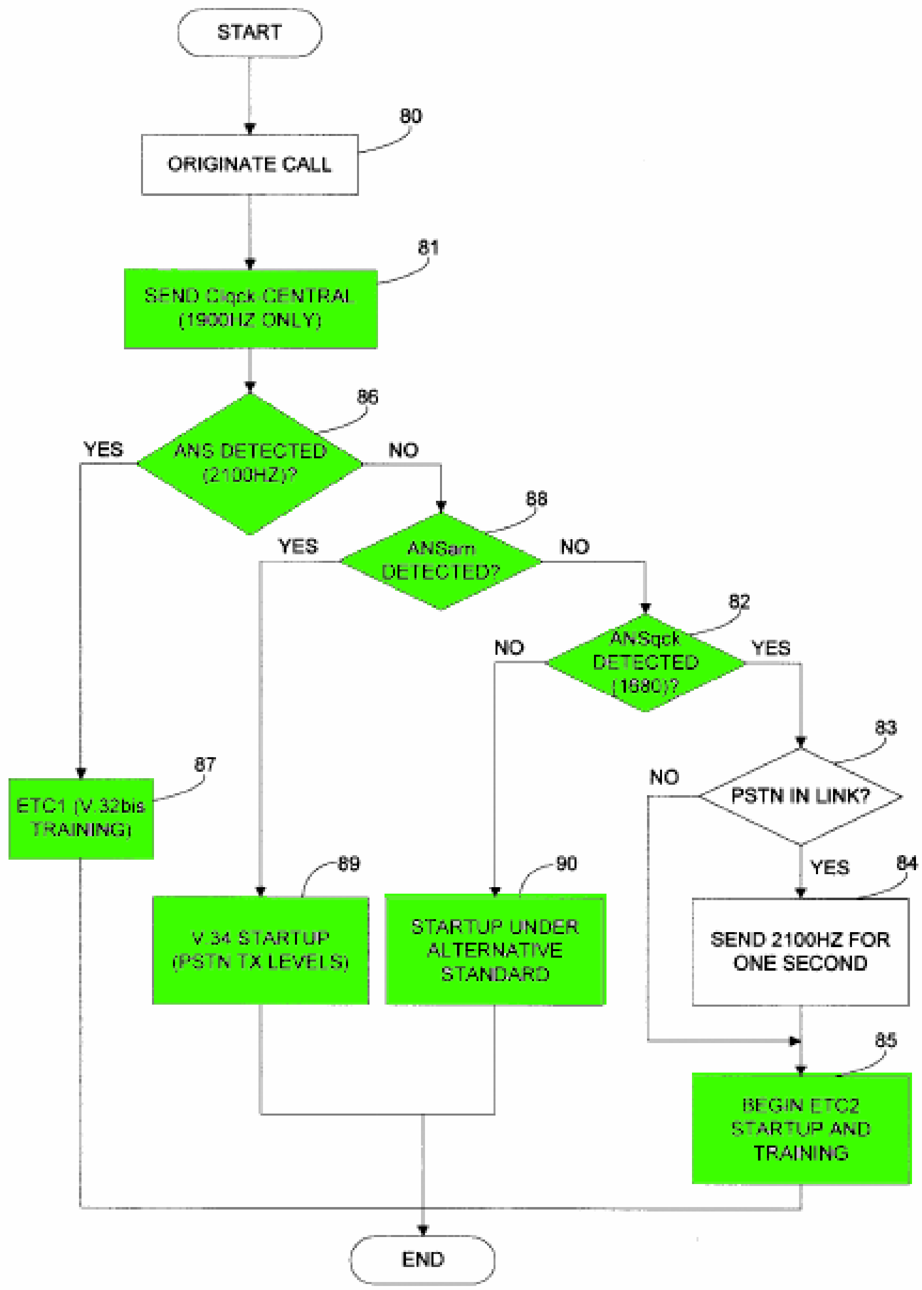
EXHIBIT 5-B



Answer Modem -- Cellular

FIG. 5

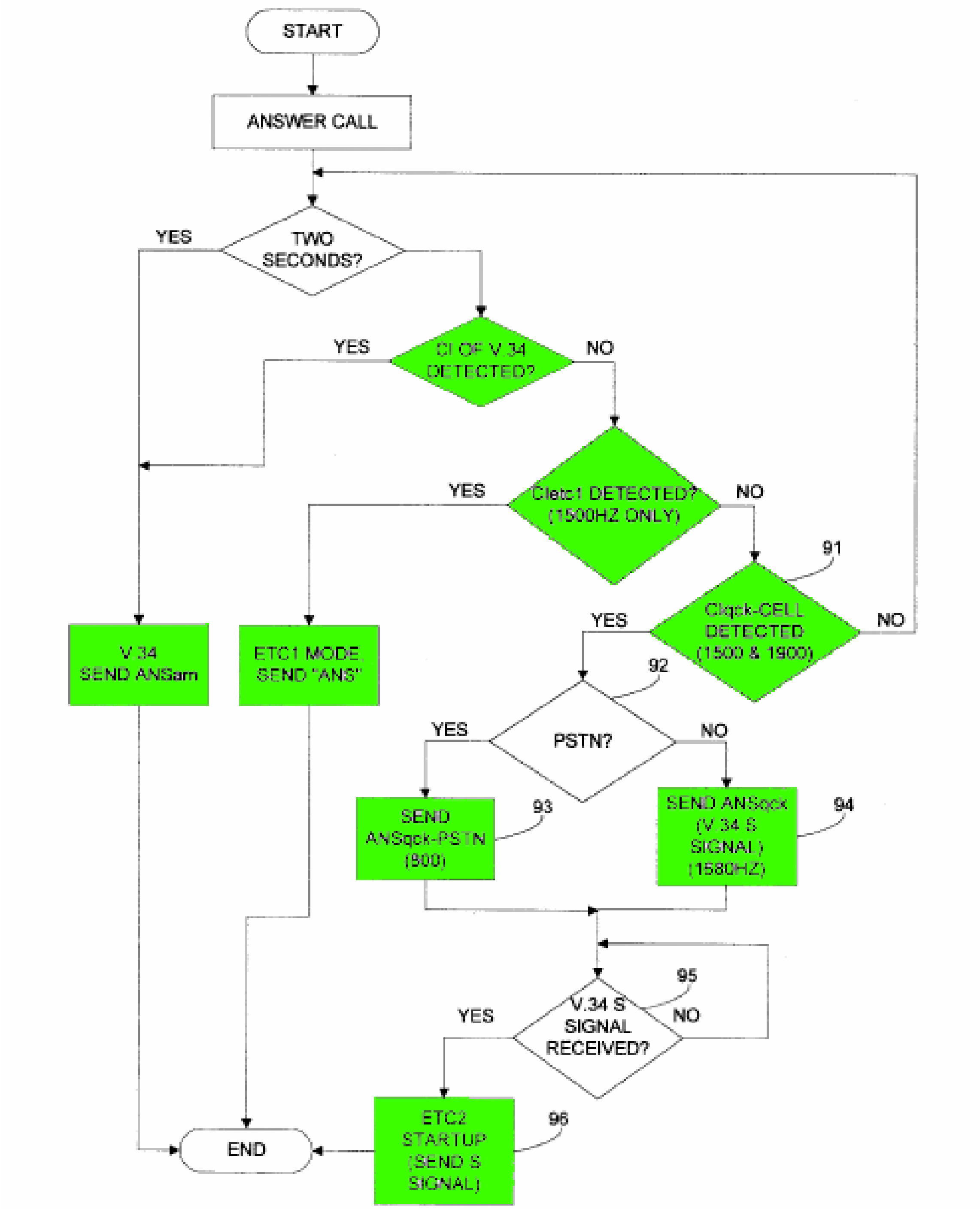
EXHIBIT 5-C



Calling Modem -- Central Site

FIG. 6

EXHIBIT 5-D

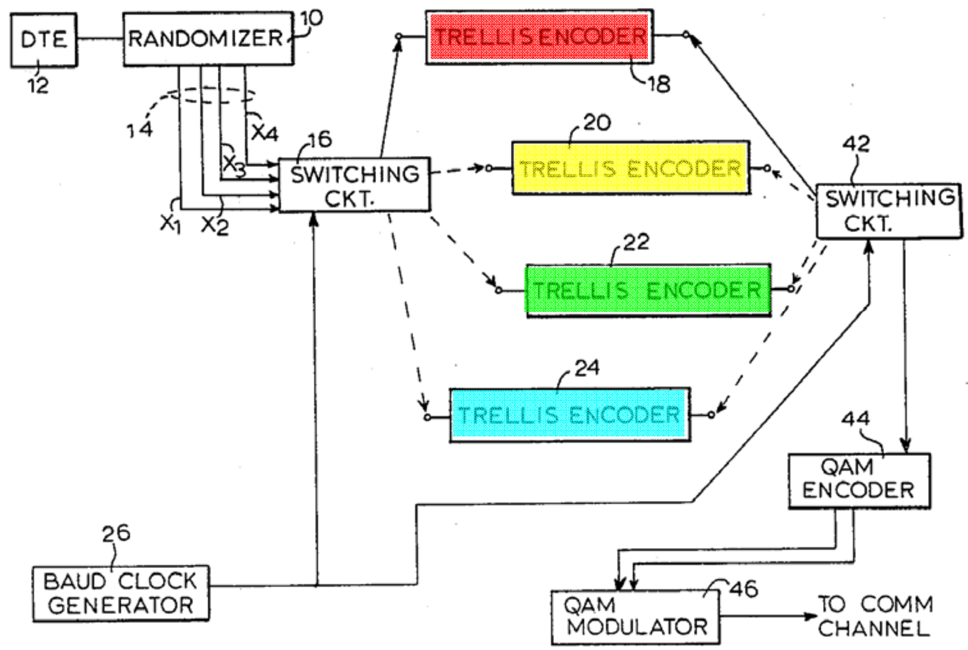


Answer Modem -- Central Site

FIG. 7

Exhibit 6

EXHIBIT 6-A



DTE
12
RANDOMIZER
10
14
X4
X3
X2
X1
16
SWITCHING CKT.
TRELLIS ENCODER
18
20
TRELLIS ENCODER
22
TRELLIS ENCODER
24
TRELLIS ENCODER
42
SWITCHING CKT.
44
QAM ENCODER
26
BAUD CLOCK GENERATOR
46
QAM MODULATOR
TO COMM CHANNEL

EXHIBIT 6-B

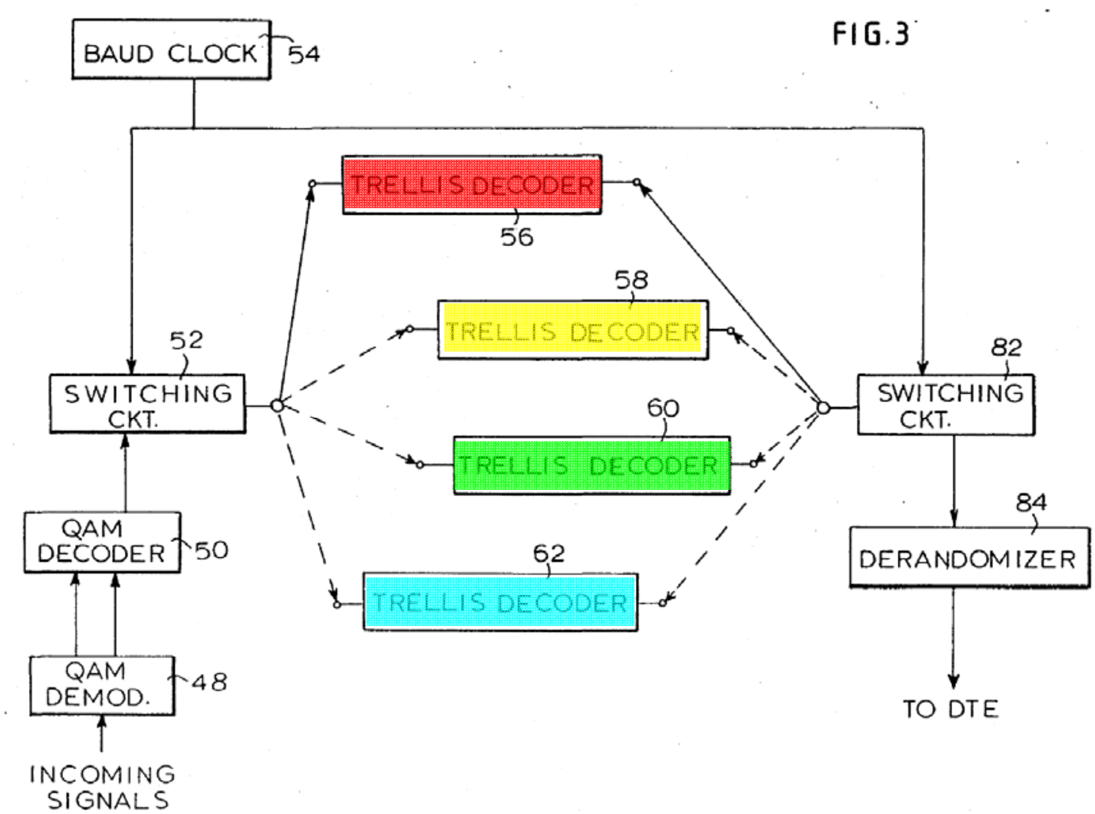


FIG.3
BAUD CLOCK
54
TRELLIS DECODER
56
58
TRELLIS DECODER
52
SWITCHING CKT.
60
TRELLIS DECODER
82
SWITCHING CKT.
QAM DECODER
50
84
DERANDOMIZER
62
TRELLIS DECODER
QAM DEMOD.
48
TO DTE
INCOMING SIGNALS

EXHIBIT 6-C

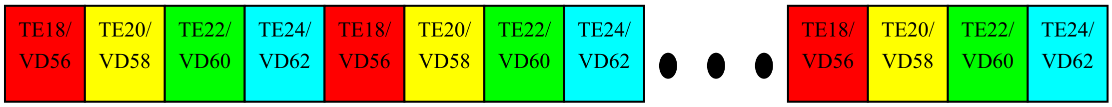
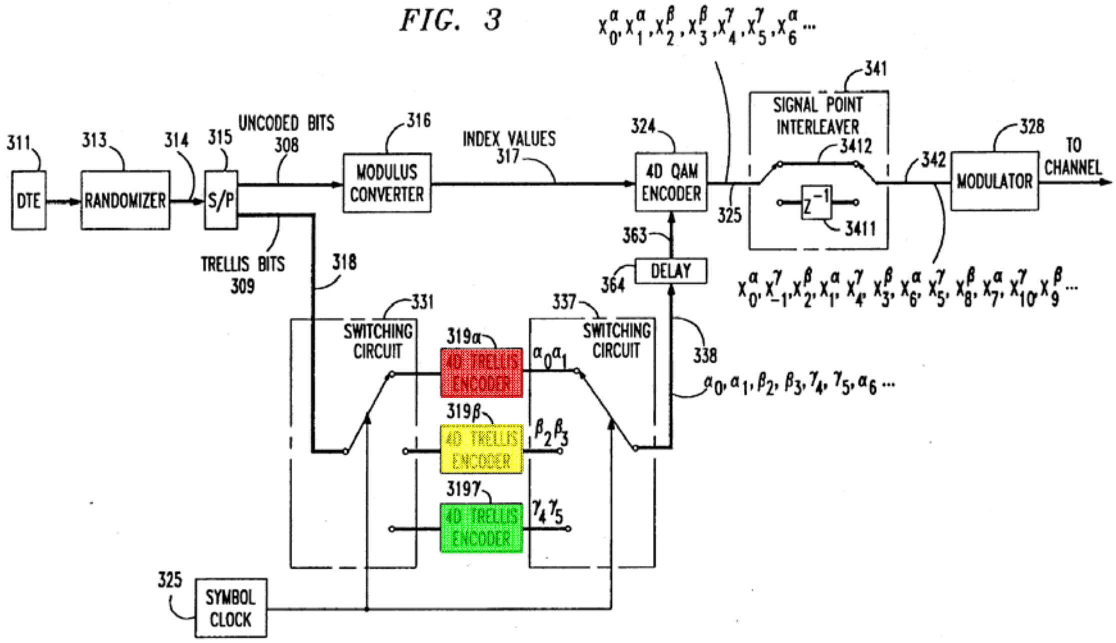
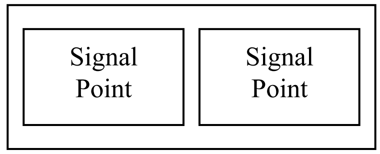

TE18/ VD56
TE20/ VD58
TE22/ VD60
TE24/ VD62
TE18/ VD56
TE20/ VD58
TE22/ VD60
TE24/ VD62
TE18/ VD56
TE20/ VD58
TE22/ VD60
TE24/ VD62

EXHIBIT 6-D

FIG. 3



<u>EXHIBIT 6-E</u>



Trellis Encoded Channel Symbol

EXHIBIT 6-F

X_0^α	X_1^α	X_2^β	X_3^β	X_4^γ	X_5^γ	X_6^α	X_7^α	X_8^β	X_9^β	X_{10}^γ	. . .

X_0^α	$X_{(-1)}^\gamma$	X_2^β	X_1^α	X_4^γ	X_3^β	X_6^α	X_5^γ	X_8^β	X_7^α	X_{10}^γ	. . .

<u>Exhibit 7</u>

{CITY}, California, {DAY}, {DATE}

{TIMES}

SILLER,

having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY {ATTY}:

{(Plaintiffs/Defendants}Exhibit No. {#} was marked for identification.)

THE VIDEOGRAPHER: Good morning. Here begins videotape number 1 in the deposition of the Curtis Siller in the matter of Rembrandt versus Comcast in the united states district court for the eastern district of the Texas Marshall division Case No. 205-CV-0 0 443-D J W. Today's date is December 20th 2006 the time is 927 A.M.

This deposition being taken at 710 Sansome Street San Francisco, California. The videographer March Marjoub here on bealh of Esquire Deposition Services 505 Sansome suite 502 San Francisco, California.

Will counsel please identify yourself and

MR. WERDEGAR: Objection form.
THE DEPONENT: It's.
MR. DEVLIN: I sorry the part -- start the part on the left is the packet channel.
A Understood you to have.
Q Let me just say it all again clearly?
A Okay.
Q Start from the start.
Looking at that dotted line middle of figure 5 it divide into two regions right?
A Correct.
Q The region on the left is the channel for packets sources?
MR. WERDEGAR: Objection form is that fair.
A Yes.
Q And the region on the right or the Charles for the synchronous sour he's?
MR. WERDEGAR: Objection form.
THE DEPONENT: Not labeled as such inferred that to be the case.
Q There are time slots shown on the left hand side of the figure?
A Right.
Q What are those?
A .

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Those are individual time slots fix in size that make up a portion of the part of the overall frame that is set aside for packet communications.

Q On the right-hand side of the figure it doesn't actually say the word time slot do you see that?

A Yes I see that.

Q Based on your understanding and reading of the entire patent is it your understanding that those time slots exist on the right-hand side of the figure also?

A That would be my understanding.

Q They are just shown in figure 5?

MR. WERDEGAR: Objection. Form.

MR. WERDEGAR: Is that fair.

A That's fair.

Q There's a Designation that start of packet 50 do you see that?

A I do.

Q And that starts thick bold line that starts on frame 1 ends at that dotted line and then continues on the left-hand side of frames 2 and 3 continues into frame 4 again on the left hand side and then ends do you see that?

after the one that's shown?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: Not from figure 5.

Q If you knew from the text of the patent this is a hypothetical if the next of the patent told you which of the packet data sources was transmitting that packet?

A Uh-huh.

Q In figure 5?

A Yes.

Q Could you tell me then what the next packet source would be to transmit a packet?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: I could not.

Q Why is that?

A Because the very next one may not have any information to send.

Q And if it doesn't what would happen?

A It would go to the next one.

Q So there's no particular order in which the packet data sources have to transmit data in the 858 patent invention?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: I believe this is the description of sequence process in which there is a se

Case 2:07-cv-00433-TJW-CE Document 191-3 Filed 06/28/2007 Page 6 of 15

again tail arbitration to invite the individual packet modules to transmit.

Q Let me see if I answer this is foundational question. There's --

A What is found.

Q There's no?

A What is foundational question.

Q I basic bit of information?

A Oh.

Q From you?

A Okay.

Q In 858 patent there's no actual sequence by which the packet sources have to transmit their information is that fair?

MR. WERDEGAR: Objection. Form.

THE DEPONENT: I think that's fair.

Q And what you are were saying before there's some sequence of arbitration right?

A Yes.

Q But that arbitration doesn't mean that the packet data sources will actually transmit in a given sequence?

A .

MR. WERDEGAR: Objection form.

THE DEPONENT: That's right.

Case 1:07-cv-00438-GMS Document 91-2 Filed 06/18/2007 Page 7 of 15

THE VIDEOGRAPHER: We are now back on the video record the time is 1109 A.M.

Q Dr. Siller could you please turn to the 858 patent and let's look at column 11.

A Okay.

Q Do you see a paragraph beginning around line 18?

A Yes I do.

Q Reference to something called a synchronous transfer mod ATM?

A That's right.

Q Do you understand what ATM is?

A Yes I do.

Q What is it?

A It's a packetzation technique for carrying a variety of traffic and most noted by the fact the packets are fixed in size.

Q Why are they fixed in size?

A It was a compromise between the telecommunication an the data industry at the particular size of the packet used ATM with carry voice are well suited to the P S T public switch telephone network where as people working in the computer more inclined to want to send packetized form so they compromised on a size that meant the needs of telephone phoney and a fact

the packetzation is used for data communications.

Q What do you mean telephone knee?

A Telephone calls.

Q There is a sentence that begins at a round line 22 in the case of ATM do you see that?

A Yes in the case of ATM.

Q Yeah I will just it says in the case of A T M cells the oxidants which form the cells need to be aligned within D S O channels do you see that?

A I do.

Q Do you understand an understanding of what A T M cell is?

A Yes I do.

Q That's that 48 bits were?

A Well it's actually 53 they are bites.

Q Bites thank you.

Is there anything else that makes up part of ATM cell?

A Well it has two ingredients it has header it has the information field part of the information field can be given over to what they call the ATM adaptation layer.

Q What is in the header?

A The header would contain addressing information yeah addressing information.

Case 2:07-cv-00493-TJW-CE Document 191-16-8 Filed 06/18/2007 Page 9 of 15

Q Anything else?
A It may indicate the fact what type of A.A.A. T M adaptation layer is being used there are 5 AA L through AA L5.
Q Okay. Are ATM when you are using an synchronous transfer mode network?
A Uh-huh.
Q Are ATM cells used for both the packetized data and for telephone phoney?
MR. WERDEGAR: Objection form.
Q Would you?
Q Simpler one. ATM cells used for telephone phoney applications in ATM networks?
MR. WERDEGAR: O. Form.
THE DEPONENT: Yes they are.
Q That sentence continues to say the objecting sits which form the cells need to be add lined within D S O channels do you see?
A I do.
Q Oxidants I am saying that right?
A Yeah you are saying that right.
MR. WERDEGAR: Objection form.
Q What does it mean by objects?
A Well the a bits make up an objecting diet so another phrase for byte is objecting diet.

MR. WERDEGAR: Objection. Form.
THE DEPONENT: I'm not sure I have an expert opinion on that.
Q Okay. In any case there's nothing in that phrase that we just read or anything else that can think of that states that the network timing means actually does that division right?
A Right.
Q Okay.
A In fact I believe that the structure that is counterpart to the patent claim terms you had me read.
Q When structure now let's talk about that.
I'm looking at the chart again I am sorry?
A That's sorry.
Q This A 23 to A 24 on A 24 you see the structure?
A Fine.
Q Right?
A Okay.
Q Structure designate the network timing control processor 12 right?
A Correct.
Q You provide citations there.
A Yeah.
Q Can you this what exactly is the structure

Q I'm with you there but I'm asking you so let's just start at the start again?
A Okay.
Q This text doesn't specify that this transmission from the master unit to each of respect remote units is performed by the ranging means right?
A That's correct.
Q Okay. The master unit includes the ranging means?
A It does.
Q But there's other things in the master unit also right?
A That's right.
Q Okay it could be something else in the master unit that perform that transmission function?
MR. WERDEGAR: Objection leading form.
Q Is that fair?
A Yes that's fair.
Q Okay. Let's talk now about the function that you layout -- let back back up for a second apart from claim language we just been discussing is there any else in patent so we talking about the bass your opinion this is in fact subject to 112, 6?
A That's light.
Q Claim range we talked about it right?

Case 1:07-cv-00393-GMS Document 11-3 Filed 06/28/2007 Page 12 of 15

A   Okay. Would you pose the question.
Q   Sure what figure out is so the application program are assigned time slots to descend information right?
A   .
MR. WERDEGAR: objection leading form beyond the scope.
THE DEPONENT: Application programs that are assigned to a time slot is that your question.
Q   Close. Let try rephrase?
MR. WERDEGAR: actually form any opinions sit you don't have that's fine.
THE DEPONENT: Yeah this is too conform an opinion right now.
Q   So you have actually reviewed claim 1 is that what you are saying?
A   .
MR. WERDEGAR: objection form leading.
THE DEPONENT: I think I was ask to testify certain ellengths of claim number 1.
Q   Sure?
A   I have formed an opinion on every aspect.
Q   Okay. You do agree with me though that the description of the patent indicated that time slots could be assigned dynamically?

Case 2:07-cv-00443-TJW-CE Document 190-18 Filed 06/18/2007 Page 13 of 15

MR. WERDEGAR: objection. Form leading beyond the scope.

THE DEPONENT: I have read that in the description.

Q Let me just make sure we are on the same page what we read in the description at column 2 lines 18 through 26 do you see that?

A Yeah.

Q Indicates to you that time slots can be assign dynamically is the fair?

MR. WERDEGAR: objection form leading beyond the scope of the expert designation.

THE DEPONENT: Well master unit going to make a decision as to whether or not the requesting remote unit should use additional access slots it doesn't say that they allocated to them but.

Q Remote does decide that the requesting unit get they are going assign dynamically correct?

MR. WERDEGAR: objection form leading beyond the copy of expert designation.

THE DEPONENT: They assign on the basis of priority information and that may not be a dynamic judgment priority could be done at initialization.

Q But that request -- let me just read through let me just note tore the record that the objections are

Q And could you give me example of that?
A I don't think of a specific example I think more words are sufficient you have to data communication flows as a decision made somehow one as a high he relevant prior toe than another and that's that.
Q What be possible one type of application data social tiff one type of application to be granted a higher priority that data associated with another application would that be possible?
MR. WERDEGAR: objection form.
THE DEPONENT: Yes I think that would be possible.
Q Were you dealing with any issues of priority in the late 1980s or early 1990s when this patent was in the patent office and when it was filed?
MR. WERDEGAR: objection. Form.
THE DEPONENT: No I don't think I was.
Q You personally you weren't?
A That's correct.
Q Okay do you think it would have been within the skill of someone in the field to be able to assign priority based on one application versus another at that time in 1989?
MR. WERDEGAR: objection. Form.
THE DEPONENT: Within my profession experience

associated with that application number 1 to say that I set them or whomever would set them is not divulged here.

Q Let me confirm what you said. This figure indicates that there can be priority bits associated with that application one is that fair reading of it?

MR. WERDEGAR: objecting form objection leading beyond the scope.

THE DEPONENT: Yes.

Q And then you could also have priority bits associated with application two right?

MR. WERDEGAR: same objections.

THE DEPONENT: Yes.

Q And you could have excuse me have priority bits associated with application N?

MR. WERDEGAR: same objections.

THE DEPONENT: Yes.

Q And those prior bits could be different between application two and application two is that fair?

MR. WERDEGAR: objection leading objection form [TKWROPBD] the scope.

THE DEPONENT: Depend on how many bits are that make up the priority it's only one only would be two.

<u>Exhibit 8</u>

[!CITY, STATE], [!BEGIN DAY], [!BEGIN DATE]
[!BEGIN TIME] - [!END TIME]

THIS IS A REALTIME ROUGH DRAFT TRANSCRIPT. IT IS NOT CERTIFIED BY THE CERTIFIED SHORTHAND REPORTER AND CANNOT BE OFFERED AS THE OFFICIAL CERTIFIED TRANSCRIPT OF THESE PROCEEDINGS. IT CANNOT BE CITED FROM OR USED IN ANY WAY TO REBUT OR CONTRADICT THE OFFICIAL CERTIFIED SHORTHAND REPORTER. IT IS PROVIDED FOR THE INTERNAL USE OF THE CLIENT TO WHICH IT IS PROVIDED.

HARRY BIMS, Ph.D.,

having been first duly sworn, was examined and testified as follows:

THE VIDEOGRAPHER: Good morning, here begins Videotape No. 1, in the deposition of Harry Bims, in the matter of Rembrandt versus Comcast in the United States District Court for the earn district of the Texas as marshal division case number 205 dash CV dash 00443 dash TJW, today's date is December 22nd, 2006, the time is 8:56 a.m., this deposition is being taken at 710 Sansome Street, San Francisco California, the videographer is Marty Majdoub here on /PHRAF of Esquire Deposition Services 505 Sansome Suite 502, San Francisco

Case 2:07-cv-00493-TJW-CE Document 191-9 Filed 06/28/2007 Page 3 of 26

A Well the error correction code itself does not correct data bits. It simply provides the information that is useful for the eventually correction of those error bits.
Q Well something on the receiver that is a Reed-Solomon decoder does that; right?
A Yeah the purpose of the Reed-Solomon decoder would be to take advantages of the extra information provided by a Reed-Solomon encoder for the purposes of correcting error bits.
Q And isn't it the case that in a Reed-Solomon decoder errors are corrected typically on a bytewise basis?
MR. WERDEGAR: Objection. Form.
THE WITNESS: Yeah, I would say that there are a variety of implementations for a Reed-Solomon decoder, and that you do not necessarily have to decode Reed-Solomon code words on a /PWAO*EUT by /PWAO*EUT base /STKPHREUS what's Reed-Solomon code word.
THE WITNESS: A Reed-Solomon code word is a can cat nation of bits generated from a Reed-Solomon encoder.
Q And what is the significance of the size of the Reed-Solomon code word?
MR. WERDEGAR: Objection. Form.

Case 1:07-cv-00493-GMS Document 191-9 Filed 06/28/2007 Page 4 of 26

well?
A
MR. WERDEGAR: Objection. Form.
THE WITNESS: I'm not necessarily opposed to this paragraph as written.
BY MR. KOLODNEY:
Q Okay so --
A But I do believe that again, there are other elements that are not mentioned in this paragraph that I would include in the definition.
Q Okay. So you agree that as presently understood, and as understood in the 1990s, the physical layer included at least the mechanical electrical functional and procedural characteristics to establish, maintain and release physical connections EG, data circuits, between data link entities?
MR. WERDEGAR: Objection form.
BY MR. KOLODNEY:
Q Would you agree with that?
MR. WERDEGAR: Objection. Form. Objection. Leading.
THE WITNESS: Yeah, I would say that at at least those elements would be included in the physical layer.
BY MR. KOLODNEY:

led to this patent was something that you agreed with in 1998 when you filed it.
A Yes, I believe that the invention was the -- was something I agreed with, yes.
Q And the description of how the invention worked in this patent was accurate, was it not?
A Of how the I /SREPBGS worked, yes.
Q (Invention worked)?
Q I'd like you to turn your attention to column 8, line 5?
A Okay.
Q And read for me the first two sentences -- first three sentences of that paragraph?
A It says data link layer, layer to 408 looks the same for all protocols. In one embodied /PHEPT, data link layer 408 is implemented for inbound channels in the vice driver 304 with Reed-Solomon decoding of the inbound data packets. Checks on verification an packet identification.
Q Dr. Bims, did you or did you not in the 911 patent describe the data link layer as including Reed-Solomon decoding of inbound packets?
MR. WERDEGAR: Objection. Form. Objection. Leading.
THE WITNESS: What I said here, and I'm looking

Case 1:07-cv-00498-GMS Document 19-9 Filed 06/18/2007 Page 6 of 26

word for word at what is written in this specification, is that in one embodiment, it is possible to do Reed-Solomon decoding of inbound packets, add in a data link packet in that embodiment.

BY MR. KOLODNEY:

Q So in the embodiment you were describing in this paragraph, in your patent, you describe the data link layer as including the Reed-Solomon decoding of inbound packets, did you not?

MR. WERDEGAR: Objection. Form, objection leading. And if you need.

THE WITNESS: I haven't read the patent.

MR. WERDEGAR: If you need to take time if you want to review the patent before answering the question you should feel welcome to refresh yourself.

THE WITNESS: Okay, I mean, just grab a sentence here, it's been what, 6 -- 5 years or -- when did I submit it, 8 years ago. So I know that that text that we just read refers to figures that are elsewhere in the specification and.

Q Well, I'll tell you what, you read this, and tell me when you've read enough of it to explain the 3 sentences that we just read into the record, please. Take as much time as you need.

A Okay.

Case 1:07-cv-03498-TJW Document 131-7 Filed 06/18/2007 Page 7 of 26

Q All right.
A Um-hmm.
Q So first of all, the data link layer that's referred to in column 8 of your patent is the data link layer of the OSI model; right?
A Yes.
Q That's what it says in the previous column?
A Right.
Q Okay? And the thing you're describing in column 8 is elements of a receiver; right?
A Um-hmm.
Q And the receiver in layer 2 in the data link layer is using a Reed-Solomon decoder?
A Um-hmm.
Q To decode packets that have been coded by the transmitter using a Reed-Solomon code?
MR. WERDEGAR: Objection to form.
BY MR. KOLODNEY:
Q Right?
MR. WERDEGAR: Objection form. Objection leading.
THE WITNESS: It doesn't actually say that in the specification. I think here we're just focusing on the receiver.
BY MR. KOLODNEY:

sources that I would use.

Q Okay.

MR. WERDEGAR: It does seem like we're moving into a new area you /TKOPT think it's an appropriate time to take a lunch break.

MR. KOLODNEY: Sure.

MR. WERDEGAR: Thanks.

MR. KOLODNEY:

THE VIDEOGRAPHER: We're now going off the video record. The time is 12:29 p.m.

(Lunch recess taken from [!LUNCH TIME] to [!RETURN TIME].)

THE VIDEOGRAPHER: We are now back on the individual wrote record. The time is 1:31 p.m.

BY MR. KOLODNEY:

Q Dr. Bims, was the purpose of the Reed-Solomon decoder in your 911 patent to detect and correct errors that can occur in the physical layer?

A Yes.

Q And you mentioned that some of your earlier work involved development of trellis codes; is that correct?

A Yes.

Q And was the purpose of the trellis codes that you developed to detect and correct errors that could

Case 2:07-cv-00243-TJW-CE Document 191-3 Filed 06/18/2007 Page 9 of 26

page 144

A
MR. WERDEGAR: Objection. Form.
THE WITNESS: (What's).
THE WITNESS: FEC code is a Ford error correction code.
Q And what are some examples of forwarder or correction code?
A I would say forwarder or correction codes would be, say, a hamming code /(.
Q How about a Reed-Solomon code?
A Yeah BCH codes, Reed-Solomon codes would be FEC codes.
Q Would a trellis code be a FEC code?
A Yeah, I would say so.
Q Okay. And what you just read in the /AB tract is a description of using a block forwarder or correction code in the data link layer for correcting bitter ors is is that not the case?
A That's.
MR. WERDEGAR: Objection. Objection. Form, objection leading.
THE WITNESS: Yes, that's true.
BY MR. KOLODNEY:
Q So whatever you think link layer means, the authors of this article clearly understood error

accurate one.
Q Okay. Let me then rephrase it and say would you agree that a negotiated physical modulation is selected by a method permitting two modems supporting different physical layer modulations to agree on a physical layer modulation?
A Well, again I guess that's truncated recitation of the fullness of the construction.
Q Well would you agree that it's accurate as far as it goes?
A I would agree it's an abbreviation of the correct definition.
Q Okay. And what if I added to that that one modem has to present one or more options to the other modem and the other modem has to choose from among the presented options which ones it wants to use, would that be correct?
A Well, again, as was stated here on -- in this -- in the file history on page 6, the answering modem has to be incapable of execute theing command presented to it by the calling modem for there to be negotiation and then secondly, this has to take place at run time.
Q Okay. And would you agree that if the two modems did not support all the same physical layer

THE WITNESS: Yeah, I don't believe I've made that conclusion.

BY MR. KOLODNEY:

Q No, but you've said that although the structures that are specified here or not all necessary to perform the functions, somewhere in this litany of structures we can find the necessary structure. That's what you're saying, isn't it?

A No, I'm not saying that.

Q Well, you are saying that what's listed here is more than is necessary to perform the recited function; right?

A Yeah, I could for example I've already said that I could for example eliminate Figure 8 from what I believe are the absolutely required structural elements.

Q How about Figure 9?

A Within Figure 9, I would specifically point out on Figure 9 itself the structural elements 114, 124, 120, and 124.

Q And what about those structural elements would you point out?

A What about them? /STKPHRU think those structural elements are necessary to perform the function.

A Yes.

Q Okay. And those are pieces of hardware, right?
A Yes.
Q Okay. Is there any hardware listed in figures 4 through 7?
A Let's see, figures 4 through 7, I believe, are flow charts, yes, they are all flow charts.
Q Are all the steps in figures 4 through 7 necessary to perform the function of the means for establishing a physical layer connection limitation?
A The way I would read this, figures 4 and 5 are necessary structures for performing the function as a collection, and then figures 6 and 7 are also structures, alternate structures that perform the function together, along with Figure 9 structures I pointed out.
Q So it's not accurate to say then that you need all of figures 4, /#5RBGS 6, 7 and 9, in order to be the corresponding structure to this limitation; right?
A Well, I guess my opinion here is that figures 4 and 5 in combination with the structural elements that I outlined on Figure 9, represent the necessary structures for performing the function, and figures 6 and 7 in combination with the structural elements that I mentioned before in Figure 9 would be also an alternate set of instruction towers for performing the function.

answering modem, if the answering modem indeed generated A and S QC K, the calling modem would not detect it (ANS).

Q Okay?

A And in that case, I'm not sure what would happen.

Q But if it generated something other than a 1680 Hertz response, it would be able to establish a connection; right?

A The other parts of the flow chart would be intact so.

Q And that would be a negotiated physical layer, that would be a physical layer connection based on a negotiated physical layer modulation; would it not?

MR. WERDEGAR: Objection form. Leading.

THE WITNESS: /TPH-FRPBLTS the scenario where 1680 Hertz question mark is false under that condition then the rest of the flow chart would implement ant negotiating a physical layer modulation.

Q So therefore element 61 is not necessary for the establishment of a physical layer connection based on a negotiated physical layer modulation; correct?

A One would not need 61 to do that.

Q Do you want to modify your position on what the elements of figures 4 enthuse 7 are (through) that are

the corresponding structure to this limitation?
A Well it appears that in addition to the other limitations that I put forth, that on Figure 4, that the detection of ANS QC K would actually not be required to perform a negotiated physical layer modulation.
Q Is that it?
A What I'm looking at Figure 5 (well I'm), Figure 5 is the answer modem flow chart. I would say that on Figure 5, block 71, /STKPH is necessary or is not necessary.
A Let me think clearly here.
A
Q In fact, this whole flow chart of Figure 5 only happens if box 61 in Figure 4 happens on the transmitting modem, isn't that the case?
A I wouldn't say that.
Q Well certainly box 71 corresponds to box 61, doesn't it?
A
Q So if you're not going to do box 61, you're also not going to do box 71 or 72 or 73 in Figure 5, so those must be unnecessary as well to perform the function in this limitation, isn't that right?
MR. WERDEGAR: Objection. Form. Leading.
MR. KOLODNEY: You know you keep saying

performing boxes 70 and 74 in Figure 5?
A You would have to implement box 69, I believe.
Q And 69?
A I would imagine in block 72 that a physical layer modulation is never negotiated, if V dot 34 is never received. So in that context, a physical layer modulation it's possible would never get negotiated.
Q So the answer to my question, which is that the only necessary structures in Figure 5 to perform the establishing a physical layer connection between said calling and said answer modems based on a negotiated physical layer modulation is boxes 69, 70 and 74; is that correct? If you perform those three steps, you can perform the function required by that limitation of claim 6?
A That's correct.
Q Okay. Now, turning to the next limitation, in -- the next means limitation in claims 6 which is means for establishing said link layer connection based on said physical layer modulation, Comcast has identified figures 8 to 9, column 12 line 55, to column 13 line 17, column 13, lines 34 to 41; column 13, line 55 to column 14, line 9. Do you agree with that identification of structure corresponding to the means for establishing said link layer limitation in claim 6?

page 238

A Again, I would, turning to these figures, the structure that's performing this function of establishing the link layer connection, would be in Figure 9 --
Q I just asked you whether you agreed with what is in Comcast's statement here about what the corresponding structure is.
MR. WERDEGAR: And he was answering your question, counselor, and I'd appreciate it if you wouldn't interrupt the answer in mid answer.
Q I asked him if he agreed. I didn't ask him to identify the structures which is what he was doing?
MR. WERDEGAR: You can ask him the question again, but he's entitled to answer the question without interrupting him.
MR. KOLODNEY: Do you or do you not agree with the identification of structure that is contained on page A 15 ****** of the joint claim construction statement under the Comcast column.
THE WITNESS: I do believe the structures that actually perform the function are contained what's within identified.
Q So there's more identified by Comcast than is actually necessary to perform the /TPUPGS; is that correct?

page 239

A (Function).
A Yes.
Q Comcast's statement of structure doesn't actually point out exactly which structures are necessary to perform the function recited in the means for establishing limitation of claim 6; is that right?
A The structures are there in what's listed /STKPHREU know but the listing doesn't actually identify which ones they are, does it.
A The structures, like I say, that actually perform the function are a subset of what's listed there.
Q But the subset is not identified on this list is it?
MR. WERDEGAR: Objection. Form. Leading.
THE WITNESS: You don't see it called out specifically.
BY MR. KOLODNEY:
Q So if someone reading this would not know merely from reading it what structures you had in mind, would they?
A
MR. WERDEGAR: Objection. Form. Leading.
THE WITNESS: Well, again, I guess this column is Comcast's proposed constructions, you know, it wasn't

you know -- I gave my opinions but it wasn't my proposed construction /STKPWHREUPL' not blaming you, but you agree that what's written here is not what you believe is actually the correct corresponding structure; right.

MR. WERDEGAR: Objection. Form. Leading.

THE WITNESS: I would just say that has' here is more than what's actually performing the function.

Q

BY MR. KOLODNEY:

Q

THE VIDEOGRAPHER: Counsel, ten minutes.

MR. KOLODNEY: Okay.

Q Dr. Bims have you read the '627 patent and understand what it discloses?

A Back to the '627. Yes I've read the '627 patent.

Q Do you understand the claim language in the '627 patent?

MR. WERDEGAR: Objection. Form.

THE WITNESS: I have read through it.

Q Do you believe you understand it?

A

MR. WERDEGAR: Objection. Form.

THE WITNESS: From an engineer's perspective, I have some understanding of what the claims are saying.

A A trellis encoder has changed its state because the clock signal that's presented to it causes the memory elements that comprise the state to clock -- to sample and store a new value into it.

Q Okay. So in order for a trellis encoder to output a value, there needs to be a estate change; right?

A For each new value that is output from the trellis encoder there needs to be a new state change.

Q Okay?

THE VIDEOGRAPHER: Counsel you have 2 minutes.

MR. KOLODNEY: Let's take a break.

THE VIDEOGRAPHER: Okay this is the end of videotape number /#3-RBGS we are now going off the video record. The time is 5:04 p.m. a.

(Interruption in the proceedings.)

THE VIDEOGRAPHER: This is the beginning of Videotape No. 4, we are now back on the video record. The time is 5:07 p.m.

BY MR. KOLODNEY:

Q So Dr. Bims, under your construction of trellis encoded channel symbol, the trellis encoded channel symbol cannot be generated from multiple outputs of a trellis encoder; is that correct?

A

Case 2:05-cv-00493-TJW-CE Document 191-9 Filed 06/18/2007 Page 20 of 26

Q Multiple success if I have outputs of a trellis encoder (successive)?
A A /TRET Is encoded channel symbol is from one output of a trellis encode /STKPHRER under your construction.
A Yes.
Q Of trellis encoder?
A Yes.
Q Now your construction of signal point is is a single mapped point in a signal constellation; is that your construction of signal point?
A Yes.
Q Can a single mapped point in a signal constellation be a point in a one dimensional signal constellation?
A Yes.
Q Are you familiar with VSB?
A Virginia /TEUPBLG gal side band.
Q Yes?
A Yes.
Q Does VSB have a one dimensional signal point constellation?
A You can think of it in that context if you /WABT.
Q That's an acceptable use of the term signal

point constellation?
A Yes.
Q ******?
Q Now, you've been identified as having an opinion on the meaning of the -- sorry, I missed one. Do you have an opinion about the meaning of distributed by tour /PAOE decoder in the claims of the '627 patent?
MR. WERDEGAR: Objection beyond the scope of the expert designation /(.
THE WITNESS: Well, the use of that term seemed to vary, depending on where I saw it in the specification.
Q Can you elaborate on that?
A There's the distributed /SRAB decoder singular, referring to the collection of /(/SRAB decoders and then there's the distributed /SRAB decoders /-RGS referring to the individual /SRAB decoders themselves.
Q Well, when the claim talks about the receiver having a distribute at the timed /SRAB decoder, for recovering said information, what do you think it's referring to there?
MR. WERDEGAR: Objection. Beyond the scope of his expert designation.
THE WITNESS: I really wasn't even asked to look into that.

Q Okay. Do you agree that you could implement the /SRAB decoders described in this patent in a single software program that through the use of indirect addressing of multiple arrays within memory would serve to provide the function of the multiple trellis encode errs disclosed in Figure 4 of the patent?

MR. WERDEGAR: Objection. Beyond the scope of his expert designation.

THE WITNESS:

BY MR. KOLODNEY:

Q Do you think that's within the skill of art?

A It's possible it's possible.

Q Is it within the skill of passenger of ordinary skill in the art to do that?

A I'm sure a person of ordinary skill in the art, if pressed could implement such a thing.

Q After reading this patent?

A Yes.

Q Okay. And there's certainly no ambiguity that the patent is teaching that that's an alternative way to implement the invention; right?

MR. WERDEGAR: Objection. Beyond the scope. Leading, form.

THE WITNESS: I would say that this is an embodiment of one way of implementing what it's talking

about here.
Q So implementing the /SRAB decoders, with a single program routine is one embodiment of the invention of the '627 patent; right?
A
MR. WERDEGAR: Objection. Beyond the scope.
THE WITNESS: At least that's what's presented in this column.
BY MR. KOLODNEY:
Q Okay. Now, on the means for did he interleaving limitation in claim 9 of the '627 patent, if you turn to page A 5 of the I forget what exhibit number it is, the first amended joint claim construction pre hearing statement. What exhibit is that?
A 13.
Q 13, okay, look at page A 5 of Exhibit 13, you see there the Comcast position on the function and structure corresponding to the means for deinterleaving limitation of claim 9?
A Yes.
Q And have you reviewed this prior to today?
A Yes, I have.
Q And did you agree that all of the structures identified in by Comcast as being the /KOERPDing structure are necessary to perform the function recited

in this means limitation?
A Well, there were some structural elements that I thought were not absolutely required.
Q Which ones were those?
A Looking at block 431.
Q Um-hmm?
A Is not required for did he /SPW-R leaving of the enter leave signal points.
Q Anything else?
A And that appears to be all.
Q What is deinterleaving mean?
A Deinterleaving means that it's a process that reverses the process of interleaving.
Q
Q Would you agree that any structure that reverse the interleaving process that was performed in the transmitter, in Figure 3, would be sufficient to perform the function of deinterleaving required by the means for deinterleaving limitation of claim 9?
MR. WERDEGAR: Objection. Form. Leading.
THE WITNESS: Well, the claim 9 is talking specifically about enter leave signal points so whatever deinterleaving would have to be deinterleaving, specifically the enter leave signal points.
Q So once again, here, you believe that Comcast

has identified more structure than was necessary to perform the function recited in the claim, in the means plus function claim limitation; is that correct?

A Yes.

Q

A I think I mentioned block 431.

Q Did you point that out to Comcast when you reviewed this document the first time?

A I did mention to Comcast when I saw this joint claim construction document, about block 431.

Q Did you review this document before it was filed with the court?

A

Q On November 14th, 2006?

A I did look through it.

Q And did you /POEUPT out to Comcast that they identified too much structure as corresponding to the means for deinterleaving in claim 9 of the '627 patent?

A I disclosed that to them after this document was filed.

Q Well, why didn't you disclose it before it was filed?

A When I read through this element, I think I overlooked 431.

Q And similarly, with respect to the means

variety of elements here before the output 325.
BY MR. KOLODNEY:
Q Right. But each channel symbol on line 325 corresponds to that set of bits that are spit out by the serial to parallel converter each time it's triggered by the clock signal; right, by the symbol clock?
A It's a function of those 9 bits, among other things, yes.
Q And on the receiving end the channel symbol is decoded to restore those 9 bits to the output stream; right?
A
Q The values on 414 and 463 if the system is working properly should be the same as those 9 bits that were spit out by the serial to parallel converter on the transmitter side; right?
A Let's see, the stream 438 should correspond to.
A So I would say that 414 would correspond to 308 at the receiver and 463 would correspond to 318 -- 309.
Q 309 right. So in the whole point of this system is that what you want, the output of Figure 4 should be the same as the input to Figure 3, that that's the whole point of the system to receive on the receiving end the stream of bits that were sent in on the sending end; right?

<u>Exhibit 9</u>

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

KEKER & VAN NEST, L.L.P
Attorneys At Law
710 Sansome Street
San Francisco, CA 94111-1704

ISBN 1-55937-833-6
90000

Introduction

Since the first edition in 1941 of the American Standard Definitions of Electrical Terms, the work now known as IEEE Std 100, The IEEE Standard Dictionary of Electrical and Electronics Terms, has evolved into the unique compendium of terms that it is today.

The current edition includes all terms defined in approved IEEE standards through December 1996. Terms are categorized by their technical subject area. They are also associated with the standards or publications in which they currently appear. In some cases, terms from withdrawn standards are included when no current source can be found. Earlier editions of IEEE Std 100 included terms from sources other than IEEE standards, such as technical journals, books, or conference proceedings. These terms have been maintained for the sake of consistency and their sources are listed with the standards in the back of the book.

The practice of defining terms varies from standard to standard. Many working groups that write standards prefer to work with existing definitions, while others choose to write their own. Thus terms may have several similar, although not identical, definitions. Definitions have been combined wherever it has been possible to do so by making only minor editorial changes. Otherwise, they have been left as written in the original standard.

Users of IEEE Std 100 occasionally comment on the surprising omission of a particular term commonly used in an electrical or electronics field. This occurs because the terms in IEEE Std 100 represent only those defined in the existing or past body of IEEE standards. To respond to this, some working groups obtain authorization to create a glossary of terms used in their field. All existing, approved standard glossaries have been incorporated into this edition of IEEE Std 100, including the most current glossaries of terms for computers and power engineering.

IEEE working groups are encouraged to refer to IEEE Std 100 when developing new or revised standards to avoid redundancy. They are also encouraged to investigate deficiencies in standard terms and create standard glossaries to alleviate them.

The sponsoring body for this document was Standards Coordinating Committee 10 on Definitions (SCC10), which consisted of the following members:

Jane Radatz, *Chair*

John W. Balde
Arthur Ballato
Bruce Barrow
William Carey
Frank A. Denbrock
Jay Forster
Chris Heegard
John Horch
J. L. Koepfinger
Allen H. Meitzler
Frank D. Myers
David E. Roberts
F. A. Saal
Ralph M. Showers
Edward N. Skomal
Kenneth L. Swinth
Raymond S. Turgel
Edward F. Vance

Case 2:07-cv-00498-TGM-SE Document 19-2 Filed 06/28/2007 Page 4 of 14

the signal is synchronized by it. *See also:* oscillograph. (IM) 748-1979w

synchronizing (1) (rotating machinery) The process whereby a synchronous machine, with its voltage and phase suitably adjusted, is paralleled with another synchronous machine or system. *See also:* asynchronous machine. (PE) [9]
(2) (facsimile) The maintenance of predetermined speed relations between the scanning spot and the recording spot within each scanning line. *See also:* facsimile. (COM) 168-1956w
(3) (television) Maintaining two or more scanning processes in phase. (BT) [34]
(4) (pulse terminology) The process of rendering a first pulse train or other sequence of events synchronous with a second pulse train. (IM) 194-1977w
(5) (hydroelectric power plants) Process of paralleling and connecting a synchronous generator to another source. (PE) 1020-1988r

synchronizing coefficient (rotating machinery) The quotient of the shaft power and the angular displacement of the rotor. *Note:* It is expressed in kilowatts per electrical radian. Unless otherwise stated, the value will be for rated voltage, load, power-factor, and frequency. *See also:* asynchronous machine. (PE) [9]

synchronizing or synchronism-check device (power system device function numbers) A device that operates when two ac circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits. (PE/SUB) C37.2-1979s

synchronizing reactor (power and distribution transformers) A current-limiting reactor for connecting momentarily across the open contacts of a circuit-interrupting device for synchronizing purposes. (PE) C57.12.80-1978r

synchronizing relay A programming relay whose function is to initiate the closing of a circuit breaker between two ac sources when the voltages of these two sources have a predetermined relationship of magnitude, phase angle, and frequency. (PE/SWG) C37.100-1992

synchronizing signal (1) (television) The signal employed for the synchronizing of scanning. *Note:* In television, this signal is composed of pulses at rates related to the line and field frequencies. The signal usually originates in a central synchronizing generator and is added to the combination of picture signal and blanking signal, comprising the output signal from the pickup equipment, to form the composite picture signal. In a television receiver, this signal is normally separated from the picture signal and is used to synchronize the deflection generators. (BT) [34]
(2) (facsimile) A signal used for maintenance of predetermined speed relations between the scanning spot and recording spot within each scanning line. *See also:* facsimile signal. (COM) 168-1956w
(3) (oscillograph) A signal used to synchronize repetitive functions. *See also:* oscillograph. (IM) [40]
(4) (telecommunications) A special signal which may be sent to establish or maintain a fixed relationship in synchronous systems. (COM) [49]

synchronizing signal compression (television) The reduction in gain applied to the synchronizing signal over any part of its amplitude range with respect to the gain at a specified reference level. *Notes:* 1. The gain referred to in the definition is for a signal amplitude small in comparison with the total peak-to-peak composite picture signal involved. A quantitative evaluation of this effect can be obtained by a measurement of differential gain. 2. Frequently the gain at the level of the peaks of synchronizing pulses is reduced with respect to the gain at the levels near the bases of the synchronizing pulses. Under some conditions, the gain over the entire synchronizing signal region of the composite picture signal may be reduced with respect to the gain in the region of the picture signal. *See also:* television. (BT) [34]

synchronizing signal level (television) The level of the peaks of the synchronizing signal. *See also:* television. (BT) [34]

synchronizing torque (synchronous machines) The torque produced, primarily through interaction between the armature currents and the flux produced by the field winding, tending to pull the machine into synchronism with a connected power system or with another synchronous machine. (PE) [9]

synchronous (1) A mode of transmission in which the sending and receiving terminal equipment are operating continuously at the same rate and are maintained in a desired phase relationship by an appropriate means. (COM) 1007-1991
(2) Protocol operation in which only one exchange between a given pair of entities can be handled at any moment in time. The current exchange must complete before the next can be initiated. (C/LM) 15802-2-1995
(3) Describes an activity specified by a function that is expected to be complete when the function returns. (C/MM) 855-1990

synchronous booster converter A synchronous converter having a mechanically connected alternating-current reversible booster connected in series with the alternating-current supply circuit for the purpose of adjusting the output voltage. *See also:* converter. (EEC/PE) [119]

synchronous booster inverter An inverter having a mechanically connected reversible synchronous booster connected in series for the purpose of adjusting the output voltage. *See also:* converter. (EEC/PE) [119]

synchronous capacitor (rotating machinery) A synchronous machine running without mechanical load and supplying or absorbing reactive power to or from a power system. *See also:* converter; synchronous condenser. (PE) [9]

synchronous circuit A circuit in which clock pulses synchronize the operations of the elements. *Contrast:* asynchronous circuit. (C) 610.10-1994

synchronous communication *See:* synchronous transmission.

synchronous computer (1) A computer in which each event, or the performance of each operation, starts as a result of a signal generated by a clock. *Contrast:* asynchronous computer. (C) [20], [85], 610.10-1994
(2) A computer in which each event or operation is performed upon receipt of a signal generated by the completion of a previous event or operation, or upon availability of the system resources required by the event or operation. (C) 610.10-1994

synchronous condenser* (1) (electric installations on shipboard) A synchronous phase modifier running without mechanical load, the field excitation of which may be varied so as to modify the power factor of the system: or through such modification, to influence the load voltage. (IA) 45-1983r
(2) A synchronous machine running without mechanical load and supplying or absorbing reactive power. *See also:* synchronous capacitor. (PE) [9]
* Deprecated.

synchronous converter (electric installations on shipboard) A converter which combines both motor and generator action in one armature winding and is excited by one magnetic field. It is normally used to change ac power to dc power. (IA) 45-1983r

synchronous coupling (electric coupling) An electric coupling in which torque is transmitted by attraction between magnetic poles on both rotating members which revolve at the same speed. The magnetic poles may be produced by direct current excitation, permanent magnet excitation, or alternating current excitation, and those on one rotating member may be salient reluctance poles. (EM/PE) 290-1980w

synchronous detector A device whose output is proportional to the amplitude of a vector component of an input RF or IF signal measured with respect to an externally supplied reference signal. (AE) 686-1990w

synchronous device (data transmission) A device whose speed of operation is related to the rest of the system to which the device is connected. (PE) 599-1985w

Exhibit 10

IEEE Std 100-1992

The New IEEE Standard Dictionary of Electrical and Electronics Terms
[Including Abstracts of All Current IEEE Standards]

Fifth Edition

Gediminas P. Kurpis, Chair

Christopher J. Booth, Editor

IEEE

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1993 by the
Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 1993
Printed in the United States of America

ISBN 1-55937-240-0

*No part of this publication may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.*

January 15, 1993

SH15594

portable appliance may be connected by means of an attachment plug cap. [90]

appliance, portable (electric system). An appliance that is actually moved or can easily be moved from one place to another in normal use. *See:* **appliance.** [86]

appliance, stationary (electric system). An appliance that is not easily moved from one place to another in normal use. *See:* **appliance.** [86]

application (computer applications). The use to which a computer system is put; for example, a payroll application, an airline application, or a network application. 610.2-1987, 610.5-1990

application generator. A code generator that produces programs to solve one or more problems in a particular application area; for example, a payroll generator. 610.12-1990

application-oriented language (software). A computer language with facilities or notations applicable primarily to a single application area; for example, a language for computer-assisted instruction or hardware design. *See also:* **authoring language; specification language; query language; simulation language.** 610.12-1990

application program. A computer program that is used for a specific application. 610.5-1990

application software. Software designed to fulfill specific needs of a user; for example, software for navigation, payroll, or process control. *Contrast with:* **support software; system software.** 610.12-1990

application valve (brake application valve). An air valve through the medium of which brakes are automatically applied. [119]

application view. *See:* **logical database.** 610.5-1990

applicative order. A property of a programming language or procedure: the arguments to a procedure call are evaluated before the procedure is invoked, and the result of each evaluation is passed to the procedure in place of its argument expression. 1178-1990

applicator (electrodes) (dielectric heating). Appropriately shaped conducting surfaces between which is established an alternating electric field for the purpose of producing dielectric heating. 54-1955w

applied-fault protection (power switchgear). A protective method in which, as a result of relay action, a fault is intentionally applied at one point in an electrical system in order to cause fuse blowing or further relay action at another point in the system. C37.100-1981, C37.90-1978

applied-potential tests (electric power). Dielectric tests in which the test voltages are low-frequency alternating voltages from an external source applied between conducting parts, and between conducting parts and ground. 32-1972

applied voltage (corona measurement). Voltage that is applied across insulation. Applied voltage may be between windings or from winding(s) to ground. 436-1977

applied voltage tests (power and distribution transformer). Dielectric tests in which the test voltages are low-frequency alternating voltages from an external source applied between conducting parts and ground without exciting the core of the transformer being tested. C57.12.80-1978

approach circuit. A circuit used to announce the approach of trains at block or interlocking stations. [119]

approach indicator. A device used to indicate the approach of a train. [119]

approach-light beacon (illuminating engineering). An aeronautical ground light placed on the extended centerline of the runway at a fixed distance from the runway threshold to provide an early indication of position during an approach to a runway. *Note:* The runway threshold is the beginning of the runway usable for landing. [127]

approach lighting. An arrangement of circuits so that the signal lights are automatically energized by the approach of a train. [119]

approach-lighting relay. A relay used to close the lighting circuit for signals upon the approach of a train. [119]

approach lights (illuminating engineering). A configuration of aeronautical ground lights located in extension of a runway or channel before the threshold to provide visual approach and landing guidance to pilots. [127]

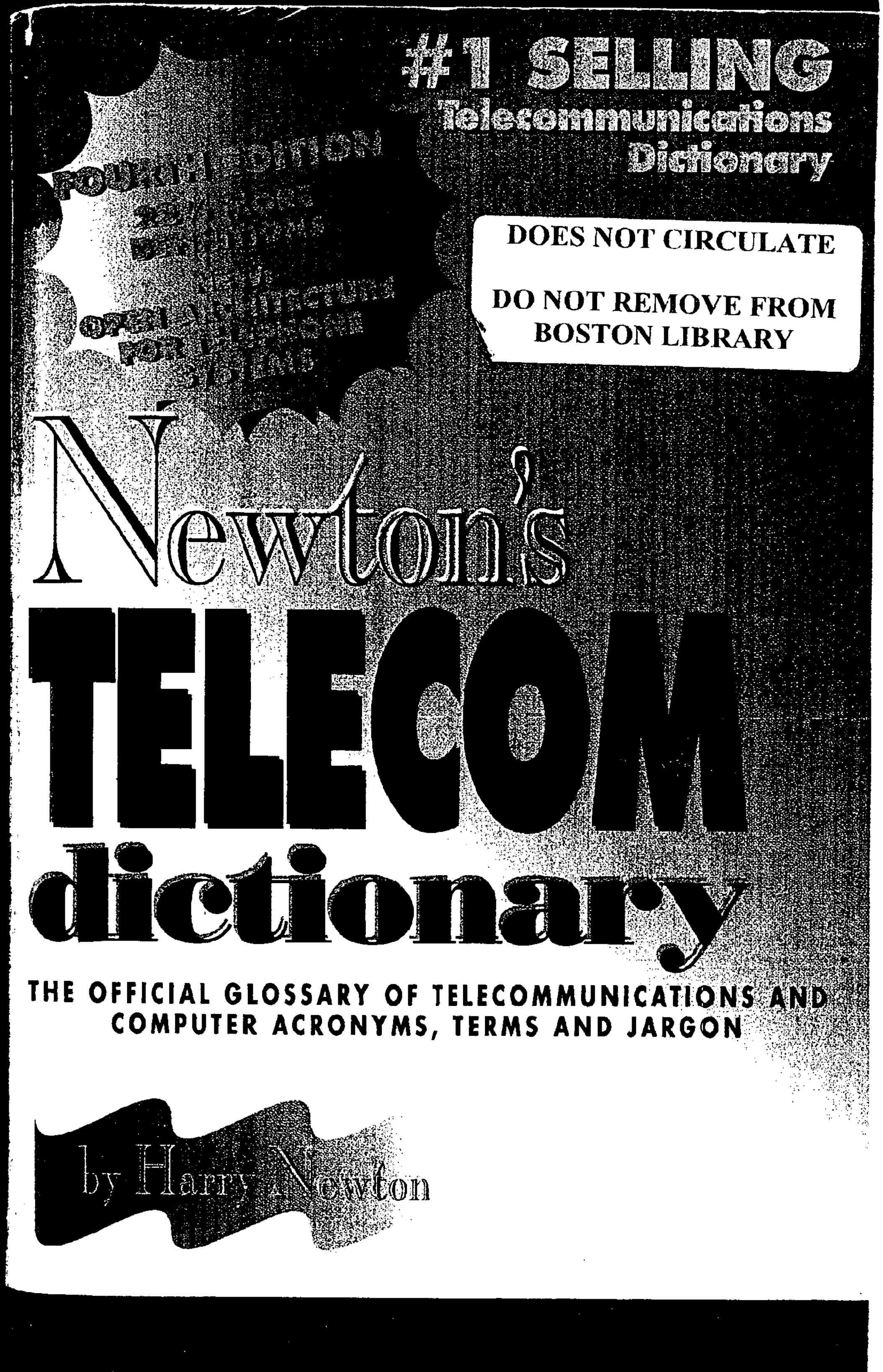
approach locking (electric approach locking). Electric locking effective while a train is approaching, within a specified distance, a signal displaying an aspect to proceed, and that prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable-point frog, or derail in the route governed by the signal, and that prevents an aspect to proceed from being displayed for any conflicting route. *See:* **interlocking.** [119]

approach navigation (navigation aid terms). Navigation during the time that the approach to a dock, runway, or other terminal facility is of immediate importance. 172-1983

approach path (navigation aid terms). That portion of the flight path between the point at which the descent for landing is normally started and the point at which the aircraft touches down on the runway. 172-1983

REM 0086618

Exhibit 11



#1 SELLING
Telecommunications
Dictionary
FOURTH EDITION
DOES NOT CIRCULATE
DO NOT REMOVE FROM
BOSTON LIBRARY
Newton's
TELECOM
dictionary
THE OFFICIAL GLOSSARY OF TELECOMMUNICATIONS AND
COMPUTER ACRONYMS, TERMS AND JARGON
by Harry Newton

NEWTON'S TELECOM DICTIONARY

Published by Telecom Library Inc.
Telecom Library publishes books and magazines and runs seminars on telephones, telecommunications, local area networks, data communications software and hardware. It also distributes the books of other publishers, making it the "central source" for all the above materials. Call or write for your **FREE** catalog.

Other Books by Telecom Library

The TELECOM LIBRARY Guide to
- T-1 Networking
- Negotiating Telecommunications Contracts
- Buying Short Haul Microwave
- The Guide to Frame Relay
- The Inbound Telephone Call Center
- SONET: Planning, Installing & Maintaining Broadband Networks

The TELECONNECT Guide to
- Automatic Call Distributors
- The Business of Interconnect
- How to Sell Call Accounting Systems
- Professional Selling

and...
- 101 Money-Saving Secrets Your Phone Company Won't Tell You
- Frames, Packets and Cells in Broadband Networking
- Profit and Control Through Call Accounting
- Telecommunications Management for Business and Government
- The Dictionary of Sales and Marketing Technology Terms
- Which Phone System Should I Buy?

FREE Catalog of Books

Telecom Library publishes books itself, and also distributes the books of every other telecommunications publisher.

You may receive your **FREE** copy of our latest catalog by calling 212-691-8215, or by dropping a line to the Christine Fullam, Telecom Library Manager, at the address below.

You may order your Telecom Library books by calling 1-800-LIBRARY or 1-800-999-0345; or fax your order to 212-691-1191.

Quantity Purchases

If you wish to purchase this book, or any others, in quantity, please contact:

Christine Fullam, Manager
Telecom Library Inc.
12 West 21 Street
New York, NY 10010
1-800-LIBRARY or 212-691-8215
Facsimile orders: 212-691-1191

Copyright 1991©, Telecom Library Inc. All rights reserved. This book was designed and produced by Randi Ripley and Jennifer Cooper-Farrow, Telecom Library. Printed in USA at BookCrafters, Chelsea, MI ISBN 0-936648-29-5

Telecom Library Inc., 12 West 21 Street, New York, NY 10010
212-691-8215 1-800-LIBRARY

APD Avalanche PhotoDiode. A diode that, when hit by light, increases its electrical conductivity by a multiplication effect. APDs are used in lightwave receivers because the APDs have great sensitivity to weakened light signals (i.e. those which have travelled long distances over fiber).

API Application Program Interface. A set of standard software interrupts, calls, and data formats that application programs use to initiate contact with network services, mainframe communications programs, or other program-to-program communications. For example, applications use APIs to call services that transport data across a network. Standardization of APIs at various layers of a communications protocol stack provides a uniform way to write applications. NetBIOS is an early example of a network application programming interface. Also, applications use APIs to call services that transport data across a network..

APL Automatic Program Load in telecom. In data processing, it's a popular programming language.

APLT See Advanced Private Line Termination.

APM Average Positions Manned, the average number of ACD positions manned during the reporting period for a particular group.

APOLOGIZE To lay the foundation for a future offense.

APPC 1. Advanced Peer-to-Peer Communications, also called Logical Unit 6.2, an IBM-specified network node definition featuring high-level program interaction capabilities on a peer-to-peer basis. 2. Advanced Program-to-Program Communications. An IBM protocol analogous to the OSI model's session layer: it sets up the necessary conditions that enable application programs to send data to each other through the network.

APPC/PC An IBM product that implements APPC on a PC.

APPEARANCE Usually refers to a private branch exchange line or extension which is on (i.e. "appears") on a multi-button key telephone. For example, extension 445 appears on three key systems.

APPEARANCE — TEST POINT The point at which a circuit may be measured by test equipment.

APPGEN A shortened form of the words APPlications GENerator.

APPLETALK Apple Computer's proprietary local area network for linking Macintosh computers and peripherals, especially LaserWriter printers. Appletalk is a CSMA/CD network that runs at 230.4 kilo bits per second and is therefore, incompatible with any other local area network. It is also a lot slower than the present top speeds of Ethernet (10 Mbps) and Token Ring (16 Mbps). Outside manufacturers, however, make gateways which will connect an Appletalk LAN to other local area and telecommunications networks — LANs, WANs and MANs. AppleTalk's LAN hardware is LocalTalk.

APPLICATION A software program that carries out some useful task. Database managers, spreadsheets, communications packages, graphics programs and word processors are all applications.

<u>Exhibit 12</u>

Jupiterwebcasts Fast-Track .NET Integration Into WebSphere. Sign up now and download the Jumpstart SOA whitepaper.

Test Drive Rational Application Developer Online
Evaluate IBM Rational Application Developer for WebSphere without installing it.
Design, develop, analyze, test, and deploy high-quality Web, SOA, Java, & J2EE apps.

Are blades right for you? Don't guess. Assess. IBM BladeCenter can simplify your infrastructure. This online tool, co-sponsored by AMD™ Opteron™, helps determine if blades are right for you.

internet.com (Webopedia) The #1 online encyclopedia dedicated to computer technology

Enter a word for a definition... Go!

...or choose a computer category. choose one... Go!

MENU
- Home
- Term of the Day
- New Terms
- Pronunciation
- New Links
- Quick Reference
- Did You Know?
- Categories
- Tech Support
- Webopedia Jobs
- About Us
- Link to Us
- Advertising

Compare Prices: go
HardwareCentral

About Us

Webopedia is a free online dictionary for words, phrases and abbreviations that are related to computer and Internet technology.

Webopedia provides easy-to-understand definitions in plain language, avoiding the use of heavy jargon when possible so that the site is accessible to users with a wide range of computer knowledge.

Full-time experienced editors gather information from standards bodies, leading technology companies, universities, professional online technical publications, white papers and professionals working in the field. The sources used are often listed in the links section below the definition if the sources can provide more information than was included in the definition. Every definition is verified among multiple sources; definitions are never based on just one source.

Talk To Us...
Submit a URL
Suggest a Term
Report an Error

YAHOO! shopping

internet.com
Developer
International
Internet Lists
Internet News
Internet Resources
IT
Linux/Open Source
Personal Technology
Small Business
Windows Technology
xSP Resources
Search internet.com
Advertise
Corporate Info
Newsletters
Tech Jobs
E-mail Offers

internet commerce
Be a Commerce Partner
GPS
Computer Memory
Tech Jobs
Executive MBA
Business Web Hosting
Domain Registration
Promos and Premiums
Price Search
Online Booking Hotels
2nd Mortgage
Laptop Computers
Special Ed Masters
Car Insurance Quotes

The definitions on Webopedia evolve and change as technologies change, so the definitions are frequently updated to reflect trends in the field. New terms are added on a daily basis, and many of the new terms come from suggestions from the site's users.

In addition to a definition of the term or phrase, Webopedia also provides links to sources of further information on the topic where applicable.

Webopedia is part of the internet.com network of Web sites owned and managed by Jupitermedia Corporation.

← Replay
IBM
Web seminars featuring Gartner analysts and live Q&A.
→ Register now.

JupiterWeb networks:

internet.com | EARTHWEB | dev | graphics.com

Search JupiterWeb: Find

Jupitermedia Corporation has two divisions: Jupiterimages andJupiterWeb

Jupitermedia Corporate Info

Copyright 2006 Jupitermedia Corporation All Rights Reserved.
Legal Notices, Licensing, Reprints, & Permissions, Privacy Policy.

Web Hosting | Newsletters | Tech Jobs | Shopping | E-mail Offers

<u>Exhibit 13</u>

Wikipedia

From Wikipedia, the free encyclopedia

Editing of this article by unregistered or newly registered users is currently disabled.
Such users may discuss changes, request unprotection, login, or create an account (http://en.wikipedia.org/w/index.php?title=Special:Userlogin&type=signup).

Wikipedia is a multilingual, Web-based, free-content encyclopedia project. The name is a portmanteau of the words *wiki* and *encyclopedia*. Wikipedia is written collaboratively by volunteers, allowing most of its articles to be edited by almost anyone with access to the Web site. Its main servers are in Tampa, Florida, with additional servers in Amsterdam and Seoul.

Wikipedia

URL	http://www.wikipedia.org/
Commercial?	No
Type of site	Internet encyclopedia project
Registration	Optional
Available language (s):	multi-lingual (171 active editions)
Owner	Wikimedia Foundation
Created by	Jimmy Wales and Larry Sanger

Wikipedia was launched as an English language project on January 15, 2001, as a complement to the expert-written and now defunct Nupedia, and is now operated by the non-profit Wikimedia Foundation. It was created by Larry Sanger and Jimmy Wales; Sanger resigned from both Nupedia and Wikipedia on March 1, 2002. Wales has described Wikipedia as "an effort to create and distribute a multi-lingual free encyclopedia of the highest possible quality to every single person on the planet in their own language".[1]

Wikipedia has more than six million articles in many languages, including more than 1.5 million articles in the English-language version and more than half a million in the German-language version. There are 250 language editions of Wikipedia, and 18 of them have more than 50,000 articles. The German-language edition has been distributed on DVD-ROM, and there have been proposals for an English DVD or print edition. Since its inception, Wikipedia has steadily risen in popularity,[2] and has spawned several sister projects. According to Alexa, Wikipedia ranks among the top fifteen most visited sites, and many of its pages have been mirrored or forked by other sites, such as Answers.com.

There has been controversy over Wikipedia's reliability and accuracy, with the site receiving criticism for its susceptibility to vandalism, uneven quality and inconsistency, systemic bias, and preference for consensus or popularity over credentials. Information is sometimes unconfirmed and questionable, lacking the proper sources that, in the eyes of most "Wikipedians" (as Wikipedia's contributors call themselves), are necessary for an article to be considered "high quality". However, a 2005 comparison (http://www.nature.com/news/2005/051212/full/438900a.html) performed by the science journal *Nature* of sections of Wikipedia and the *Encyclopædia Britannica* found that the two were close in terms of the accuracy of their articles on the natural sciences. This study was challenged by Encyclopædia Britannica, Inc., who described it as "fatally flawed".[3]

Contents

Characteristics

Wikipedia uses a type of software called a "wiki", which allows for content to be authored by multiple people easily. Visitors are allowed to add, remove, or otherwise edit and change its content to help build the encyclopedia. Such contributions can be made without the need to register a user account.[4] It is therefore possible for large numbers of people to write articles and update them quickly as new information becomes available; it also means online vandalism of and disagreement about content are common.

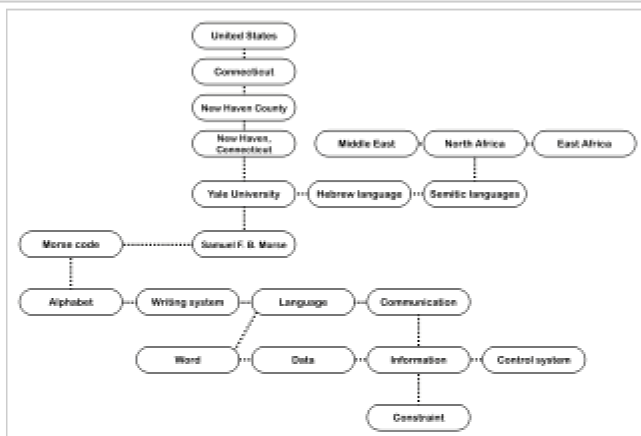


Image depicting the linking characteristics of a wiki; pages are linked together extensively, which allows the user to traverse a pathway of related articles

Many other Internet encyclopedia projects use traditional multi-lingual editorial policies and article ownership such as the expert-written *Stanford Encyclopedia of Philosophy*, Nupedia, h2g2 and Everything2. Projects such as Susning.nu, *Enciclopedia Libre*, and WikiZnanie are other wikis in which articles are developed by numerous authors, and there is no formal process of review. Unlike many encyclopedias, Wikipedia has licensed its content under the GNU Free Documentation License (GFDL).

Wikipedia has a set of policies identifying types of information appropriate for inclusion. These policies often are

cited in disputes over whether particular content should be added, revised, transferred to a sister project, or removed. One of Wikipedia's core policies is that articles must be written from a "neutral point of view", presenting all noteworthy perspectives on an issue along with the evidence supporting them. The project also forbids the use of original research. Wikipedia articles do not attempt to determine an objective truth on their subjects, but rather to describe them impartially from all significant viewpoints. Following the introduction of a more user friendly citation functionality, since early 2006, articles increasingly include an extensive reference section to support the information presented in the article and to allow verification of the article.

Free content

As a large and collaborative project that requires users to create and edit content *en masse*, it is imperative that all contributions be freely modifiable legally. Normally the creator of a work retains copyright over it, disallowing others from copying it or creating derivative works. It is for this reason that Wikipedia's articles are released under a license that permits anyone to build upon them. The "GNU Free Documentation License", or "GFDL", one of the many "copyleft" licenses that permit the redistribution, creation of derivative works, and commercial use of content, was chosen for this purpose. The license also states that, as a condition for the use of the information, its authors be attributed and any redistributed content remain available under the same license. Despite this free nature, the contributions of original material to the project by authors are still rightfully theirs, and the copyright over their work is retained by them; they simply agree to make that work available so that others may benefit from it. Contributors may choose to multi-license their content as well, which allows it to be used by third parties under any of the licenses, or simply release them into the public domain.

A significant proportion of images, sound and video files on Wikipedia, however, do not fall under the GFDL license. Items such as corporate logos, song samples, or copyrighted news photos are used with a claim of fair use under the United States copyright law.[5] There is also content released under different copyleft terms or licenses that are compatible with the GFDL, such as images under Creative Commons licenses.

Language editions

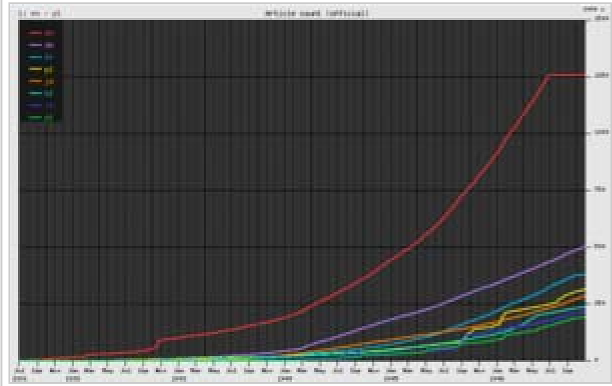
An example of Wikipedia's range in language editions: Wikipedia in Hebrew.[6]

Wikipedia encompasses 171 "active" language editions (ones with 100+ articles).[7] In total, Wikipedia contains 250 language editions of varying states, with a combined 5 million articles.[8]

Language editions operate independently from one another. Editions are not bound to the content of other language editions, nor are articles on the same subject required to be translations of each other. Automated translation of articles is explicitly disallowed, though multilingual editors of sufficient fluency are encouraged to manually translate articles. The various language editions are held to global policies such as "neutral point of view", though they may diverge on subtler points of policy and practice. Articles and images are shared between Wikipedia editions, the former through "InterWiki" links and pages to request translations, and the latter through the Wikimedia Commons repository. Translated articles represent only a small portion of articles in most editions.[9]

According to Alexa Internet's audience measurement service, the English sub-domain (en.wikipedia.org) receives approximately 60% of Wikipedia's cumulative traffic, with the remaining 40% being splintered between

the numerous other languages in which Wikipedia is offered.

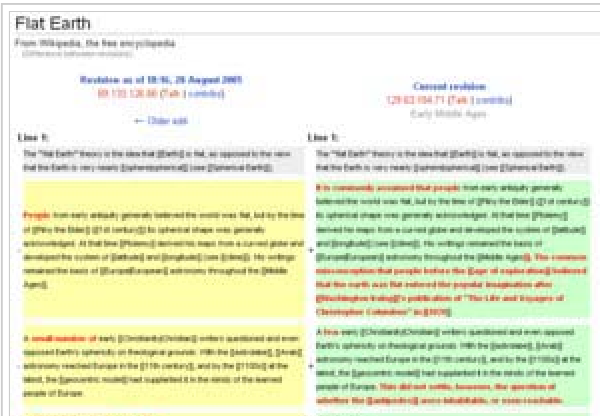

Wikipedia's article count has shown rapid growth in some of the major language editions.

The following is a list of the largest editions — those containing over 100,000 articles — sorted by number of articles as of December 24, 2006.[10][8]

1. English (1,548,289 (http://en.wikipedia.org/wiki/Special:Statistics?uselang=en))
2. German (516,026 (http://de.wikipedia.org/wiki/Special:Statistics?uselang=en))
3. French (412,112 (http://fr.wikipedia.org/wiki/Special:Statistics?uselang=en))
4. Polish (327,752 (http://pl.wikipedia.org/wiki/Specjalna:Statistics?uselang=en))
5. Japanese (304,023 (http://ja.wikipedia.org/wiki/Special:Statistics?uselang=en))
6. Dutch (248,317 (http://nl.wikipedia.org/wiki/Special:Statistics?uselang=en))
7. Italian (226,407 (http://it.wikipedia.org/wiki/Special:Statistics?uselang=en))
8. Portuguese (210,861 (http://pt.wikipedia.org/wiki/Special:Statistics?uselang=en))
9. Swedish (200,059 (http://sv.wikipedia.org/wiki/Special:Statistics?uselang=en))
10. Spanish (181,955 (http://es.wikipedia.org/wiki/Special:Statistics?uselang=en))
11. Russian (123,573 (http://ru.wikipedia.org/wiki/Special:Statistics?uselang=en))
12. Chinese (106,459 (http://zh.wikipedia.org/wiki/Special:Statistics?uselang=en))

Editing

Almost all visitors may edit Wikipedia's content; registered users can also create new articles. Changes made to pages are instantly displayed. Wikipedia is built on the expectation that collaboration among users will improve articles over time, in much the same way that open-source software develops. Some of Wikipedia's editors have explained its editing process as a "socially Darwinian evolutionary process".[11] This real-time, collaborative model allows editors to rapidly update existing topics as they develop and to introduce new ones as they arise.



Editors keep track of changes to articles by checking the difference between two revisions of a page, displayed here in red.

Some take advantage of Wikipedia's openness to add nonsense to the encyclopedia, which is called "vandalism". Additionally, collaboration sometimes leads to "edit wars" — multiple people repetitively replacing or removing each other's contributions because they disagree with each other — and prolonged disputes when editors are unable to agree on an article's content.[12]

Articles are always subject to editing, unless the article is protected for a short time owing to the aforementioned vandalism or revert wars. Wikipedia does not declare any of its articles to be "complete" or "finished". The authors of articles need not have any expertise or qualifications in the subjects that they edit, and users are warned

The "recent changes" page shows the newest edits to the English Wikipedia. This page is often watched by users who revert vandalism.

that their contributions may be "edited mercilessly and redistributed at will" by anyone who wishes to do so. Articles are not controlled or copyrighted by any particular user or editorial group; decisions on the content and editorial policies of Wikipedia are instead made largely through consensus decision-making and, occasionally, by vote. Jimmy Wales retains final judgment on Wikipedia policies and user guidelines.[13]

Regular users often maintain a "watchlist" of articles of interest to them, so that they can easily keep tabs on all recent changes to those articles, including new updates, discussions, and vandalism. Most past edits to Wikipedia articles also remain viewable after the fact and are stored on "edit history" pages sorted chronologically, making it possible to see former versions of any page at any time. The only exceptions are the entire histories of articles that have been deleted, and many individual edits that contain libelous statements, copyright violations, and other content that could incur legal liability or be otherwise detrimental to Wikipedia. These edits may only be viewed by Wikipedia administrators.

Wikipedia in other formats

For some articles, there is a spoken version available in `ogg` format (using the Vorbis audio codec). The `ogg` format is favored over the more ubiquitous and better-known `MP3` format due to the decision to favor content accessible with "Free software" — `MP3` fails this criteria as it is covered by multiple enforced software patents.[14]

As Wikipedia is available online and released under an unrestrictive license, it is very easy to download its content for use on containers other than the Web, which is its primary distribution method. Accordingly, some projects have sprung up that use the Wikipedia content differently. For example, SOS Children distributes the encyclopedia on a CD (2006 Wikipedia CD Selection). Additionally, an editorial team is working on creating "Wikipedia 1.0", a collection of Wikipedia articles that have been verified for accuracy and are ready for printing or burning to CD. Published copies of selected Wikipedia articles are also available from PediaPress, a Print on Demand service.[15] Stand-alone versions are available for handheld devices (for example, Lexipedia and Encyclopodia).

History

Wikipedia originally developed out of another encyclopedia project, Nupedia.

The Wikipedia concept was not novel — Everything2 (in 1998-1999) had used similar ideas before Wikipedia was founded — and Wikipedia began as a complementary project for Nupedia, a free online encyclopedia project whose articles were written by experts through a formal process. Nupedia was founded on March 9, 2000, under the ownership of Bomis, Inc, a Web portal company. Its principal figures were Jimmy Wales, Bomis CEO, and Larry Sanger, editor-in-chief for Nupedia and later Wikipedia. Nupedia was described by Sanger as differing from existing encyclopedias in being open content, in not having size limitations, due to being on the Internet, and in being free of bias, due to its public nature and potentially broad base of contributors.[16] Nupedia had a seven-step review process by appointed subject-area experts, but later came to be viewed as too

slow for producing a limited number of articles. Funded by Bomis, there were initial plans to recoup its investment by the use of advertisements.[16] It was initially licensed under its own Nupedia Open Content License, switching to the GFDL before Wikipedia's founding at the urging of Richard Stallman.

Jimmy Wales, Wikipedia co-founder and head of the Wikimedia Foundation

On January 10, 2001, Larry Sanger proposed on the Nupedia mailing list to create a wiki alongside Nupedia. Under the subject "Let's make a wiki", he wrote:[17]

> No, this is not an indecent proposal. It's an idea to add a little feature to Nupedia. Jimmy Wales thinks that many people might find the idea objectionable, but I think not. (…) As to Nupedia's use of a wiki, this is the ULTIMATE "open" and simple format for developing content. We have occasionally bandied about ideas for simpler, more open projects to either replace or supplement Nupedia. It seems to me wikis can be implemented practically instantly, need very little maintenance, and in general are very low-risk. They're also a potentially great source for content. So there's little downside, as far as I can determine.

Wikipedia was formally launched on January 15, 2001, as a single English-language edition at http://www.wikipedia.com/, and announced by Sanger on the Nupedia mailing list.[18] It had been, from January 10, a feature of Nupedia.com in which the public could write articles that could be incorporated into Nupedia after review. It was relaunched off-site after Nupedia's Advisory Board of subject experts disapproved of its production model.[19] Wikipedia thereafter operated as a standalone project without control from Nupedia. Its policy of "neutral point-of-view" was codified in its initial months, though it is similar to Nupedia's earlier "nonbiased" policy. There were otherwise few rules initially. Wikipedia gained early contributors from Nupedia, Slashdot postings, and search engine indexing. It grew to approximately 20,000 articles, and 18 language editions, by the end of its first year. It had 26 language editions by the end of 2002, 46 by the end of 2003, and 161 by the end of 2004.[20] Nupedia and Wikipedia coexisted until the former's servers went down, permanently, in 2003, and its text was incorporated into Wikipedia.

Wikipedia's English edition on March 30, 2001, two and a half months after its founding.

Wales and Sanger attribute the concept of using a wiki to Ward Cunningham's WikiWikiWeb or Portland Pattern Repository. Wales mentioned that he heard the concept first from Jeremy Rosenfeld, an employee of Bomis who showed him the same wiki, in December 2000,[21] but it was after Sanger heard of its existence in January 2001 from Ben Kovitz, a regular at the wiki,[19] that he proposed the creation of a wiki for Nupedia to Wales and Wikipedia's history started. Under a similar concept of free content, though not wiki-based production, the GNUpedia project existed alongside Nupedia early in its history. It subsequently became inactive, and its creator, free-software figure Richard Stallman, lent his support to Wikipedia.[22]

Citing fears of commercial advertising and lack of control in a perceived English-centric Wikipedia, users of the Spanish Wikipedia forked from Wikipedia to create the *Enciclopedia Libre* in February 2002. Later that

year, Wales announced that Wikipedia would not display advertisements, and its website was moved to wikipedia.org. Various other projects have since forked from Wikipedia for editorial reasons, such as Wikinfo, which abandoned "neutral point-of-view" in favor of multiple complementary articles written from a "sympathetic point-of-view".[23]

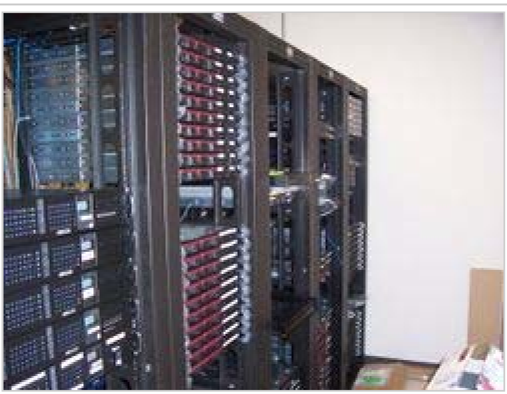
Wikipedia's first sister project, "In Memoriam: September 11 Wiki", was created in October 2002 to detail the September 11, 2001 attacks;[24] The Wikimedia Foundation was created from Wikipedia and Nupedia on June 20, 2003.[25] Wikipedia and its sister projects thereafter operated under this non-profit organization. Wiktionary, a dictionary project, was launched in December 2002; Wikiquote, a collection of quotations, a week after Wikimedia launched; and Wikibooks, a collection of collaboratively-written free books, the next month. Wikimedia has since started a number of other projects, detailed below.

Wikipedia has traditionally measured its status by article count. In its first two years, it grew at a few hundred or fewer new articles per day; by 2004, this had accelerated to a total of 1,000 to 3,000 per day (counting all editions). The English Wikipedia reached its 100,000-article milestone on January 22, 2003.[26] Wikipedia reached its one millionth article, among the 105 language editions that existed at the time, on September 20, 2004,[27] while the English edition alone reached its 500,000th on March 18, 2005.[28] This figure had doubled less than a year later, with the millionth article in the English edition, Jordanhill railway station (http://en.wikipedia.org/wiki/Jordanhill_railway_station), being created on March 1, 2006[29]; meanwhile, the millionth user registration had been made just two days before. The 1.5 millionth article was created on November 25, 2006 about the Kanab Ambersnail. [30]

The Wikimedia Foundation applied to the United States Patent and Trademark Office to trademark *Wikipedia*® on September 17, 2004. The mark was granted registration status on January 10, 2006. Trademark protection was accorded by Japan on December 16, 2004 and in the European Union on January 20, 2005. Technically a service mark, the scope of the mark is for: "Provision of information in the field of general encyclopedic knowledge via the Internet".

There are plans to license the usage of the Wikipedia trademark for some products, such as books or DVDs.[31]

Software and hardware



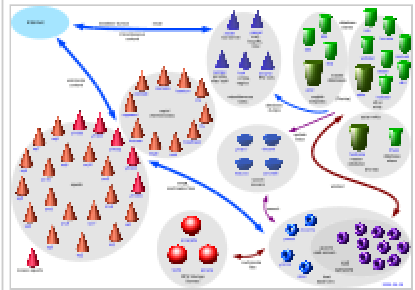
Wikipedia receives over 2000 page requests per second. More than 100 servers have been set up to handle the traffic.

Wikipedia itself runs on its own in-house created software, known as MediaWiki, a powerful, open source wiki system written in PHP and built upon MySQL.[32] As well as allowing articles to be written, it includes a basic internal macro language, variables and transcluded templating system for page enhancement, and features such as redirection.

Wikipedia runs on a cluster of dedicated Linux servers located in Florida and four other locations around the world.[33] MediaWiki is Phase III of the program's software. Originally, Wikipedia ran on UseModWiki by Clifford Adams (Phase I). At first it required camel case for links; later it was also possible to use double brackets. Wikipedia began running on a PHP wiki engine with a MySQL database in January 2002. This software, Phase II, was written specifically for the Wikipedia project by Magnus Manske. Several rounds of modifications were made to improve performance in response to increased demand. Ultimately, the software was rewritten again, this time by Lee Daniel Crocker. Instituted in July 2002, this Phase III software was called MediaWiki. It was licensed under

the GNU General Public License and used by all Wikimedia projects.

Wikipedia was served from a single server until 2004, when the server setup was expanded into a distributed multitier architecture. In January 2005, the project ran on 39 dedicated servers located in Florida. This configuration included a single master database server running MySQL, multiple slave database servers, 21 web servers running the Apache software, and seven Squid cache servers. By September 2005, its server cluster had grown to around 100 servers in four locations around the world.



Overview of system architecture, May 2006 (see also: *Server layout diagrams*)

Page requests are processed by first passing to a front-end layer of Squid caching servers. Requests that cannot be served from the Squid cache are sent to two load-balancing servers running the Perlbal software, which then pass the request to one of the Apache web servers for page-rendering from the database. The web servers serve pages as requested, performing page rendering for all the Wikipedias. To increase speed further, rendered pages for anonymous users are cached in a filesystem until invalidated, allowing page rendering to be skipped entirely for most common page accesses, which can lead to a lag. To further increase response times, Wikimedia began building a global network of caching servers with the addition of three caching servers in France. Two larger clusters in the Netherlands and Korea now take much of Wikipedia's traffic load. In spite of all this, Wikipedia page load times remain quite variable. The ongoing status of Wikipedia's website is posted by users at a status page (http://openfacts.berlios.de/index-en.phtml?title=Wikipedia_Status) on OpenFacts.

Authorship and management process

During December 2005, Wikipedia had about 27,000 users who made at least five edits that month; 17,000 of these active users worked on the English edition.[34] A more active group of about 4,000 users made more than 100 edits per month, over half of these users having worked in the English edition. According to Wikimedia, one-quarter of Wikipedia's traffic comes from users without accounts, who are less likely to be editors.[35]

Maintenance tasks are performed by a group of volunteer developers, stewards, bureaucrats, and administrators, which number just over a thousand. Administrators are the largest such group, privileged with the ability to prevent articles from being edited, delete articles, or block users from editing in accordance with community policy. Any editor with a significant history of positive contributions and a firm understanding of Wikipedia's policies and guidelines can be nominated to become an administrator.

Some users have been temporarily or permanently blocked from editing Wikipedia. Vandalism or the minor infraction of policies may result in a warning or temporary block, while long-term or permanent blocks for prolonged and serious infractions are given by Jimmy Wales or, on its English edition, an elected Arbitration Committee.

Former Nupedia editor-in-chief Larry Sanger has said that having the GFDL license as a "guarantee of freedom is a strong motivation to work on a free encyclopedia".[36] In a study of Wikipedia as a community, economics professor Andrea Ciffolilli argued that the low transaction costs of participating in wiki software create a catalyst for collaborative development, and that a "creative construction" approach encourages participation.[37] Wikipedia has been viewed as an experiment in a variety of social, political, and economic systems, including anarchy, democracy, and communism. Its founder has replied that it is not intended as one, though that is a consequence.[38] Daniel Brandt of Wikipedia Watch has referred to Jimbo Wales as the "dictator" of Wikipedia; however, most Wikipedia users either do not consider Wales to be a dictator, or consider him to be one who rarely

gives non-negotiable orders.[39]

Future directions for authoring content

An experimental feature planned for the German version of Wikipedia has been reported which could eventually improve the quality of editing for Wikipedia and protect it from vandalism. The concept being tested is to still allow anyone to edit articles, but to only allow editors judged as "trustworthy" to make edits live on the public site. The process by which trustworthiness would be established is yet to be determined. Jimbo Wales stated "We want to let anybody edit but we don't want to show vandalized versions. It would be fun for me to announce to the press that the front page of Wikipedia is open for public editing for the first time in five years".[40]

Funding

Wikipedia is funded through the Wikimedia Foundation. Its 4th Quarter 2005 costs were $321,000 USD, with hardware making up almost 60% of the budget.[41]

Bomis, an online advertising company that caters to a generally male audience and has hosted soft-core pornography, played a significant part in the early development of Wikipedia and the network itself.[42] Wikipedia holds regular fundraisers asking the community for donations.[43]

Criticism and controversy

Further information: Criticism of Wikipedia

Wikipedia has become increasingly controversial as it has gained prominence and popularity, with critics alleging that Wikipedia's open nature makes it unauthoritative and unreliable, with unconfirmed information that often lacks any proper sources, and that it exhibits severe systemic bias and inconsistency. Wikipedia has also been criticized for using dubious sources, having a biased but neutrally written perspective towards certain points of view, for disregarding credentials, for lacking understanding and international nature, and for being vulnerable to vandalism and special interest groups.[44] Critics of Wikipedia include Wikipedia's own editors (and ex-editors), representatives of other encyclopedias, and even subjects of articles, especially those that find information presenting them in a bad light.

At the end of 2005, controversy arose after journalist John Seigenthaler, Sr. found that his biography had been written largely as a hoax, which had gone undetected for 132 days. [45] This discovery led to several policy decisions within Wikimedia regarding creation of articles and the overview process, intended to address some of the flaws which had allowed the hoax to go undetected for that time.

The Wikipedia model

Wikipedia has been both praised and criticized for being open to editing by anyone. Critics allege that non-expert editing undermines quality. Because contributors usually submit *edits*, rewriting small portions of an entry rather than making full-length revisions, high- and low-quality content may be intermingled within an entry.

Wikipedia has been criticized for a perceived lack of reliability, comprehensiveness and authority. It is criticized as having no or limited utility as a reference work among many librarians, academics, and the editors of more formally written encyclopedias. Many university lecturers discourage their students from using any encyclopedia as a reference in academic work, preferring primary sources instead.[46] A critical website, Wikipedia Watch, was created by Daniel Brandt, accusing Wikipedia of having "…a massive, unearned influence on what passes for

Case 1:07-cv-00493-RMC Document 19-14 Filed 06/28/2007 Page 11 of 20

reliable information."[47]

Supporters argue that Wikipedia does meet all the criteria for the basic definition of the word 'encyclopedia'. One difference from book encyclopedias is online web editing with Wikipedia's history function. A deleted text will remain in the history tab and other users can look up an individual's work history to gauge the author's merit.

Emigh and Herring (2005)[48] in a study of Wikipedia, note that there are not yet many formal studies of Wikipedia or its model. Their main conclusions regarding style and encyclopedic quality were:

1. Statistically speaking, "the language of Wikipedia entries is as formal as that in the traditional print encyclopedia".
2. Wikipedia entries are "stylistically homogenous, typically describe only a single, core sense of an item, and are often presented in a standard format" (attributed partly to policies and partly to the norms of conventional print encyclopedias "which Wikipedia effectively emulates").
3. Wikipedia achieves its results by social means, including self-norming, a core of active and vigilant users watching for problems, and editors' expectations of encyclopedic text drawn from the wider culture.

Reliability

Wikipedia can be assessed for reliability in several areas, including:

- Accuracy of information provided within articles;
- Comprehensiveness, scope and coverage within articles and in the range of articles;
- Susceptibility to, and exclusion and removal of, false information (a criterion specific to the Wikipedia process);
- Susceptibility to editorial and systemic bias;
- Identification of reputable third party source references (citations).

Accuracy and comprehensiveness

A variety of studies to date have tended to suggest that some Wikipedia articles (scientific articles most notably) are of a similar degree of accuracy to *Encyclopædia Britannica*, that Wikipedia provides a good starting point for research, and that articles are, in general, reasonably sound. However, these studies also suggest that due to its novel editorial model, it suffers omissions and inaccuracies which can sometimes be serious. A separate study suggests that in many cases, vandalism is reverted fairly quickly, but that this does not always happen.

One of the studies, by *Nature*, identified that among 42 entries tested, the difference in accuracy was relatively low: the average science entry in Wikipedia contained around four inaccuracies; Britannica, around three. In the pairs of articles reviewed, eight serious errors such as misinterpretations of important concepts were detected, four from each encyclopædia. Reviewers also found many factual errors, omissions or misleading statements: 162 in Wikipedia and 123 in Britannica. However, the study did find that the errors on Wikipedia were generally more severe, with a greater proportion of factual errors, while the errors in Britannica were more commonly errors of omission. However, it was also found that Wikipedia articles were generally of greater length (2.6 times as long as the Britannica equivalents, on average), and that thus its error per word ratio is lower.[49]

Critics of Wikipedia often charge that allowing anyone to edit makes Wikipedia an unreliable work, and that some editors may employ clever use of semantics to make possibly biased statements sound more credible. Wikipedia contains no formal peer review process for fact-checking, and the editors themselves may not be well-versed in the topics they write about, leading to criticism that its contents lack authority,[50] and according to Danah Boyd, that "[i]t will never be an encyclopedia, but it will contain extensive knowledge that is quite valuable for different purposes."[51]

Although Wikipedia has a policy of citing reputable sources, this is only sometimes adhered to. *Encyclopædia Britannica*'s executive editor, Ted Pappas, was quoted in *The Guardian* as saying: "The premise of Wikipedia is that continuous improvement will lead to perfection. That premise is completely unproven."[50] and former *Britannica* editor Robert McHenry criticized the wiki approach on the grounds that "What [a user] certainly does not know is who has used the facilities before him". [52]

Academic circles have not been exclusively dismissive of Wikipedia as a reference. Wikipedia articles have been referenced in "enhanced perspectives" provided on-line in *Science*. The first of these perspectives to provide a hyperlink to Wikipedia was "A White Collar Protein Senses Blue Light",[53] and dozens of enhanced perspectives have provided such links since then. However, these links are offered as background sources for the reader, not as sources used by the writer, and the "enhanced perspectives" are not intended to serve as reference material themselves.

Former Nupedia editor-in-chief Larry Sanger criticized Wikipedia in late 2004 for having, according to Sanger, an "anti-elitist" philosophy of active contempt for expertise.[54] It is possible that articles subject to strong opinions (such as George W. Bush) are more prone to be edited poorly, but this is uncertain — often such articles receive extra attention and strong consensus exactly because they are the subject of heated debate. Other articles that do not produce such emotive responses may tend to be more stable.

Other commentators have drawn a middle ground, that it contains much valuable knowledge and has some reliability, even if the degree is not yet assessed with certainty. People taking such a view include Danah Boyd, Larry Sanger (re-applying Eric Raymond's "Given enough eyeballs, all errors are shallow"[55]) and technology figure Joi Ito, who wrote, "the question is whether something is more likely to be true coming from a source whose resume sounds authoritative or a source that has been viewed by hundreds of thousands of people (with the ability to comment) and has survived."[56]

Bill Thompson, a well known technology writer, commented that the debate is probably symptomatic of much learning about information which is happening in society today, arguing that:

> “ It is the same with search engine results. Just because something comes up in the top 10 on MSN Search or Google does not automatically give it credibility or vouch for its accuracy or importance... One benefit that might come from the wider publicity that Wikipedia is receiving is a better sense of how to evaluate information sources... The days when everything you saw on a screen had been carefully filtered, vetted, edited and checked are long gone. Product placement, advertorials and sponsorship are all becoming more common. An educated audience is the only realistic way to ensure that we are not duped, tricked, fleeced or offended by the media we consume, and learning that online information sources may not be as accurate as they pretend to be is an important part of that education. I use the Wikipedia a lot. It is a good starting point for serious research, but I would never accept something that I read there without checking. ”

—Bill Thompson, What is it with Wikipedia? (http://news.bbc.co.uk/1/hi/technology/4534712.stm)

Coverage

A common criticism is that editors, being volunteers, write on what interests them, and what they are aware of. Therefore, coverage is uneven and may at times be seriously unbalanced, with notable omissions.

Wikipedia has been accused of deficiencies in comprehensiveness because of its voluntary nature, and of reflecting the systemic biases of its contributors. For example, like any Internet group, the site can become dominated by cliques of habitual users who express condescension and hostility to users not involved in the "in-

group" — habitual users also feel a sense of "ownership" over "their" pages, leading to edit wars.

Encyclopædia Britannica's editor-in-chief Dale Hoiberg has argued this case,[50] as has former Nupedia editor-in-chief Larry Sanger who stated in 2004 that "when it comes to relatively specialized topics (outside of the interests of most of the contributors), the project's credibility is very uneven."[54]

The same fluidity that allows articles to be patchy has also led to Wikipedia being praised for making it possible for articles to be updated or created in response to current events. For example, the then-new article on the 2004 Indian Ocean earthquake on its English edition was cited often by the press shortly after the incident.[57] Its editors have also argued that, as a website, Wikipedia is able to include articles on a greater number of subjects than print encyclopedias may.[58]

Bias

Wikipedia has been criticized as having a systematic bias in three ways. First, there could be an unintentional bias due to the overall makeup of the community of Wikipedian editors. For instance, because Wikipedia's basic model is popular and nonmonetary, this could lead to a shortage of editors with elitist or strongly pro-capitalist views. There is no doubt that Wikipedia includes a wide diversity of editors, and important articles which are the focus of a controversy generally receive input from editors on both sides of this controversy; but this weak bias would tend to show up in more secondary articles. Second, there could be an intentional bias within a given article due to the focused efforts of a single editor or a small group of editors. This would also tend to be confined to secondary articles which receive less editorial attention. In general, this bias would be more or less strong, and thus possibly detectable by a critical reader. Third, there could be a bias introduced by some other aspect of Wikipedia. The tendency to use web-based sources, the policies against original research, and the injunction to maintain a "neutral point of view" could all be sources of bias, especially if overapplied.

Ojective, or neutrally biased, articles present different opinions as equally legitimate regardless of validity, while unbiased articles focus on accuracy and validity. For example, the evolution article is not objective because it does not present creationism, a counter argument to evolution, as a valid scientific theory. However, this does not make the article biased because evolution is an accepted scientific theory.

CNN's Crossfire, on the other hand, was considered objective because it had representatives from the political right from the political left.

Community

The Wikipedia community (http://meta.wikimedia.org/wiki/The_Wikipedia_Community) consists of users who are proportionally few, but highly active. Emigh and Herring argue[48] that "a few active users, when acting in concert with established norms within an open editing system, can achieve ultimate control over the content produced within the system, literally erasing diversity, controversy, and inconsistency, and homogenizing contributors' voices."[48] Editors on Wikinfo, a fork of Wikipedia, similarly argue that new or controversial editors to Wikipedia are often unjustly labeled "trolls" or "problem users" and blocked from editing.[59] Its community has also been criticized for responding to complaints regarding an article's quality by advising the complainer to fix the article (a common complaint about open-source software development as well).[60] It has also been described as "cult-like",[61][62][63][64] although, as these instances demonstrate, not always with entirely negative connotations.

In a page on researching with Wikipedia, the community view is argued that Wikipedia is valuable for being a social community, in that authors can be asked to defend or clarify their work, and disputes are readily seen.[65] Wikipedia editions also often contain reference desks in which the community answers questions.

Case 2:05-cv-00493-GMS Document 103-14 Filed 06/28/2007 Page 14 of 20

Professor James H. Fetzer criticized Wikipedia in that he could not change the article about himself; Wikipedia has a policy that prohibits the editing of biographies by the subjects themselves.[66]

This problem has caused a lack of intellectual freedom. The freedom of Wikipedia, for example, is more virtual than anything. The ability of anyone to actually create reasoning or opinions of their own is very limited on Wikipedia. The Enlightenment tradition of "Sapere aude!" does not apply to Wikipedia. Wikipedia can be in some ways the ultimate in neutral censorship. As Fahrenheit 451, by Ray Bradbury, says, "[d]on't step on the toes of the dog lovers, the cat lovers, doctors, lawyers, merchants, chiefs, Mormons, Baptists, Unitarians, second-generation Chinese, Swedes, Italians, Germans, Texans, Brooklynites, Irishmen, people from Oregon or Mexico." In short, true freedom is lost, or is in the process of being lost, to political correctness. Where are the ideals that have led to intellectual development? How can we realize, for example, Martin Luther's view of every individual being a priest, when those without recognition are cast out from developing their own ideas!?

The pages Wikipedia:Articles_for_deletion and Wikipedia:deletion_policy highlight the extent of this seeming intolerance. Situations including lack of notability and sources, as well as a lack of neutrality, can contribute to the deletion or heavy editing of an article. Where in the cases of persons or establishment, the notability rules prevent advertising, the deletion policy on biased articles can prevent the actual development of ideas or debate, and lead to the destruction of a concept merely because it was not presented in the most neutral fashion. Additionally, articles, especially when they concern the traits of ethnic or gender groups, have been edited or considered for deletion due to content that is not politically correct, even if it is true and supported by empirical data. Examples include race_and_intelligence and gender_and_intelligence. Articles such as this one, which could cause some to revise their ideas about a subject, are often considered for deletion merely because they are not yet well known.

Responses to criticisms

In an interview (http://www.businessweek.com/technology/content/dec2005/tc20051214_441708.htm) with *BusinessWeek* on December 13, 2005, Wales discussed the reasons that the Seigenthaler hoax had gone undetected, and steps being taken to address them. He stated that one problem was that Wikipedia's use had grown faster than its self-monitoring system could comfortably handle, and that therefore new page creation would be deliberately restricted to account-holders only, addressing one of Seigenthaler's main criticisms. He also gave his opinion that encyclopedias as a whole (whether print or online) were not usually appropriate for primary sources and should not be relied upon as authoritative (as some were doing), but that nonetheless on balance Wikipedia was more reliable as "background reading" on subjects than most online sources. He stated that Wikipedia was a "work in progress".[67]

In response to this criticism, proposals have been made to provide various forms of provenance for material in Wikipedia articles.[68] The idea is to provide *source provenance* on each interval of text in an article and *temporal provenance* as to its vintage. In this way a reader can know "who has used the facilities before him" and how long the community has had to process the information in an article to provide calibration on the "sense of security". For example, Cross[69] proposes a temporal provenance scheme which colors text based how many edit sessions a piece of text has survived (red for new text, yellow for text that has survived 50 edits, green if 100, black if more than 150 edits). However, these proposals for provenance are quite controversial. Aaron Krowne wrote a rebuttal article in which he criticized McHenry's methods, and labeled them "FUD", the marketing technique of "fear, uncertainty, and doubt".[70]

Awards

Wikipedia won two major awards in May 2004.[71] The first was a Golden Nica for Digital Communities,

awarded by Prix Ars Electronica; this came with a €10,000 ($12,700) grant and an invitation to present at the PAE Cyberarts Festival in Austria later that year. The second was a Judges' Webby award for the "community" category.[72] Wikipedia was also nominated for a "Best Practices" Webby. In September 2004, the Japanese Wikipedia was awarded a Web Creation Award from the Japan Advertisers Association. This award, normally given to individuals for great contributions to the Web in Japanese, was accepted by a long-standing contributor on behalf of the project.

Wikipedia has also received plaudits from sources including the *BBC News*, *The Washington Post*, *The Economist*, *Newsweek*, *Los Angeles Times*, *Science*, *The Guardian*, *Chicago Sun-Times*, *The Times* (London), *Toronto Star*, *Globe and Mail*, *The Financial Times*, *Time Magazine*, *Irish Times*, *Reader's Digest*, and *The Daily Telegraph*. Founder Jimmy Wales was named one of the 100 most influential people in the world by *TIME Magazine* in 2006.[73]

In a 2006 *Multiscope* research study, the Dutch Wikipedia was rated the third best Dutch language site (after Google and Gmail), with a score of 8.1.[74]

In popular culture

Wikipedia's content has been mirrored and forked by hundreds of sites including database dumps. Wikipedia content has also been used in academic studies, books and conferences, albeit more rarely, and very recently, in movies. As of 2006, Wikipedia has been used once in a United States court case,[75] and the Parliament of Canada website refers to Wikipedia's article on same-sex marriage in the "further reading" list of Civil Marriage Act.[76] Some Wikipedia users, or *Wikipedians*, maintain (non-comprehensive) lists of such uses.[77]

With increased usage and awareness, there have been an increasing number of references to Wikipedia in popular culture. Many parody Wikipedia's openness, with characters vandalizing or modifying the online encyclopedia project's articles. Stephen Colbert of the Colbert Report has often times instigated his viewers to vandalize articles in humorous ways, once doing so on the Wikipedia article on elephants. "Weird Al" Yankovic's character in his video 'White & Nerdy' is seen vandalising the entry for the Atlantic record label with the exclamation "You suck!", after they rescinded permission for a parody.

In the American version of Shin Megami Tensei: Digital Devil Saga, Wikipedia is a selectable mantra.

See also

- Congressional staffer edits to Wikipedia
- Encyclopedia
- Internet encyclopedia project
- List of encyclopedias
- List of wikis
- Open Site
- Self-reference
- User-generated content
- Wikipedia in popular culture

References

1. ^ Jimmy Wales, "Wikipedia is an encyclopedia (http://mail.wikipedia.org/pipermail/wikipedia-l/2005-March/038102.html)", March 8 2005, <wikipedia-l@wikimedia.org>
2. ^ See plots at "Visits per day (http://en.wikipedia.org/wikistats/EN/PlotsPngUsageVisits.htm)", Wikipedia Statistics, January 1, 2005

Case 2:05-cv-00439-FCD-CMK Document 193-14 Filed 06/28/2007 Page 16 of 20

3. ^ Encyclopædia Britannica, Inc. (March 22, 2006). "*Fatally Flawed: Refuting the recent study on encyclopedic accuracy by the journal Nature (http://corporate.britannica.com/britannica_nature_response.pdf)*" (PDF).
4. ^ Registering an account grants the user some additional privileges, such as creating and renaming ("moving") articles.
5. ^ Note that it is the United States copyright law that applies to all of Wikipedia's content.
6. ^ http://he.wikipedia.org/wiki/
7. ^ "List of Wikipedias (http://meta.wikimedia.org/wiki/List_of_Wikipedias)", Meta-Wiki, April 15, 2006
8. ^ ***a b*** "Complete list of language Wikipedias available (http://meta.wikimedia.org/wiki/Complete_list_of_language_Wikipedias_available)", Meta-Wiki, April 15, 2006
9. ^ For example, "Translation into English (http://en.wikipedia.org/wiki/Wikipedia:Translation_into_English)", Wikipedia. (March 9 2005)
10. ^ Note that the article count, however, is a limited metric for comparing the editions, for a variety of reasons. In some Wikipedia versions, for example, nearly half of the articles are short articles created automatically by robots. Furthermore, many editions that have more articles also have fewer contributors. Although the French, Polish, Dutch, Portuguese, Swedish and Italian Wikipedias have more articles than the Spanish Wikipedia, they have fewer users. See "Complete list of language Wikipedias available (http://meta.wikimedia.org/wiki/Complete_list_of_language_Wikipedias_available)", Meta-Wiki, for more information.
11. ^ "Wikipedia sociology (http://meta.wikimedia.org/wiki/Wikipedia_sociology)", Meta-Wiki, 23:30 March 24
12. ^ "Edit war (http://en.wikipedia.org/wiki/Wikipedia:Edit_war)", Wikipedia (March 26, 2005)
13. ^ "Power structure (http://meta.wikimedia.org/wiki/Power_structure)", Meta-Wiki, 10:55 April 4, 2005
14. ^ MP3 Patents (http://www.mp3licensing.com/patents/index.html) Retrieved December 27, 2006
15. ^ PediaPress (http://pediapress.com/) Retrieved 27 December 2006
16. ^ ***a b*** Larry Sanger, "Q & A about Nupedia (http://web.archive.org/web/20000510132952/www.nupedia.com/interview.html)", Nupedia, March 2000
17. ^ Larry Sanger. "Let's make a wiki (http://web.archive.org/web/20030414014355/http://www.nupedia.com/pipermail/nupedia-l/2001-January/000676.html)", *Internet Archive*, January 10, 2001.
18. ^ Larry Sanger. "Wikipedia is up! (http://web.archive.org/web/20010506042824/www.nupedia.com/pipermail/nupedia-l/2001-January/000684.html)", *Internet Archive*, January 17, 2001.
19. ^ ***a b*** Larry Sanger. "The Early History of Nupedia and Wikipedia: A Memoir (http://features.slashdot.org/features/05/04/18/164213.shtml)", *Slashdot*, April 18, 2005.
20. ^ "Multilingual statistics (http://en.wikipedia.org/wiki/Wikipedia:Multilingual_statistics)", Wikipedia, March 30, 2005
21. ^ Jimmy Wales, "Re: Sanger's memoirs (http://mail.wikipedia.org/pipermail/wikipedia-l/2005-April/039093.html)", April 20, 2005,<wikipedia-l@wikipedia.org>
22. ^ Richard Stallman. "The Free Encyclopedia Project (http://www.gnu.org/encyclopedia/encyclopedia.html)", *Free Software Foundation*, 1999.
23. ^ Wikinfo - Sympathetic point of view (http://www.internet-encyclopedia.org/wiki.php?title=Sympathetic_point_of_view). Retrieved on 2006-10-27.
24. ^ The "In Memoriam: September 11" site is not widely considered a "sister project" as of 2006; there has been calls to close the site, or move it to Wikia. "Proposals for closing projects (http://meta.wikimedia.org/w/index.php?title=Proposals_for_closing_projects&oldid=362802)", a page of the Wikimedia Meta-Wiki, discusses this process.
25. ^ Jimmy Wales: "Announcing Wikimedia Foundation (http://mail.wikipedia.org/pipermail/wikipedia-l/2003-June/010690.html)", June 20, 2003, <wikipedia-l@wikipedia.org>
26. ^ "Wikipedia, the free encyclopedia, reaches its 100,000th article (http://en.wikipedia.org/wiki/Wikipedia:Press_releases/January_2003)", Wikimedia Foundation, January 21, 2003
27. ^ "Wikipedia Reaches One Million Articles (http://meta.wikimedia.org/wiki/Wikimedia_press_releases/One_million_Wikipedia_articles_(int'l))", Wikimedia Foundation, September 20, 2004
28. ^ "Wikipedia Publishes 500,000th English Article (http://en.wikipedia.org/wiki/Wikipedia:Press_releases/March_2005)", Wikimedia Foundation, March 18, 2005
29. ^ "English Wikipedia Publishes Millionth Article (http://wikimediafoundation.org/wiki/Press_releases/English_Wikipedia_Publishes_Millionth_Article)", Wikimedia Foundation, March 1, 2006
30. ^ Note that this user count includes both sockpuppets, accounts solely used for vandalism, and unused accounts. The number of true accounts is significantly less.
31. ^ Nair, Vipin. "Growing on volunteer power (http://www.thehindubusinessline.com/ew/2005/12/05/stories/2005120500070100.htm)", *Business Line*, December 5, 2005.
32. ^ MediaWiki Homepage (http://www.mediawiki.org/wiki/MediaWiki)
33. ^ Wikimedia servers at wikimedia.org (http://meta.wikimedia.org/wiki/Wikimedia_servers)

34. ^ Paragraph's statistics taken from "Active wikipedians (http://en.wikipedia.org/wikistats/EN/TablesWikipediansEditsGt5.htm)" (Wikipedia Statistics, April 13, 2006).
35. ^ "Wikipedia (http://meta.wikimedia.org/wiki/Wikipedia)", Meta-Wiki, 08:02 March 30, 2005.
36. ^ Larry Sanger, "Britannica or Nupedia? The Future of Free Encyclopedias (http://www.kuro5hin.org/story/2001/7/25/103136/121)", Kuro5hin, July 25, 2001.
37. ^ Andrea Ciffolilli, "Phantom authority, self-selective recruitment and retention of members in virtual communities: The case of Wikipedia (http://firstmonday.org/issues/issue8_12/ciffolilli/index.html)", *First Monday* December 2003.
38. ^ Jimmy Wales, "Re: Illegitimate block (http://mail.wikimedia.org/pipermail/wikien-l/2005-January/018735.html)", January 26, 2005, <wikien-l@wikimedia.org>.
39. ^ Wikipedia is not an oligarchy or a dictatorship (http://en.wikipedia.org/wiki/Wikipedia_talk:What_Wikipedia_is_not#Wikipedia_is_not_an_oligarchy_or_a_dictatorsh *Wikipedia*. Wikimedia Foundation (2006-05-05). Retrieved on 2006-05-24.
40. ^ Daniel Terdiman, "Can German engineering fix Wikipedia? (http://news.com.com/2100-1038_3-6108495.html)", August 23, 2006, <CNET News.com>
41. ^ Budget/2005 (http://wikimediafoundation.org/wiki/Budget/2005). Wikimedia Foundation. Retrieved on 2006-03-11.
42. ^ Poe, Marshall (September 2006). The Hive (http://www.theatlantic.com/doc/200609/wikipedia). The Atlantic Monthly. Retrieved on 2006-08-08.
43. ^ Wikimedia Foundation:Fundraising (http://wikimediafoundation.org/wiki/Fundraising)
44. ^ Frank Ahrens, The Washington Post (2006-07-09). Death by Wikipedia: The Kenneth Lay Chronicles (http://www.washingtonpost.com/wp-dyn/content/article/2006/07/08/AR2006070800135.html). Retrieved on 2006-11-01.
45. ^ A false Wikipedia 'biography' (http://www.usatoday.com/news/opinion/editorials/2005-11-29-wikipedia-edit_x.htm) Paragraph 2, retrieved [[27 December], 2006
46. ^ Wide World of WIKIPEDIA (http://www.emorywheel.com/media/storage/paper919/news/2006/04/21/News/Wide-World.Of.Wikipedia-1865022.shtml)
47. ^ www.wikipedia-watch.org/
48. ^ ***a b c*** Emigh & Herring (2005) "Collaborative Authoring on the Web: A Genre Analysis of Online Encyclopedias", Proceedings of the Thirty-Eighth Hawai'i International Conference on System Sciences. (PDF (http://ella.slis.indiana.edu/~herring/wiki.pdf))
49. ^ "Wikipedia and Britannica about as accurate in science entries, reports Nature (http://en.wikinews.org/wiki/Wikipedia_and_Britannica_about_as_accurate_in_science_entries,_reports_Nature)", *Wikinews*, *Wikimedia*, December 14, 2005.
50. ^ ***a b c*** Simon Waldman, "Who knows? (http://www.guardian.co.uk/online/news/0,12597,1335892,00.html)", *The Guardian*, October 26, 2004.
51. ^ Danah Boyd, "Academia and Wikipedia (http://www.corante.com/many/archives/2005/01/04/academia_and_wikipedia.php)", Many-to-Many, January 4, 2005.
52. ^ Robert McHenry, "The Faith-Based Encyclopedia (http://www.techcentralstation.com/111504A.html)", Tech Central Station, November 15, 2004.
53. ^ Linden, Hartmut (2002-08-02). A White Collar Protein Senses Blue Light (http://www.sciencemag.org/cgi/content/summary/297/5582/777). *Science*. Retrieved on 2005. (subscription access only)
54. ^ ***a b*** Larry Sanger, "Why Wikipedia Must Jettison Its Anti-Elitism (http://www.kuro5hin.org/story/2004/12/30/142458/25)", Kuro5hin, December 31, 2004.
55. ^ "Wikipedia is wide open. Why is it growing so fast? Why isn't it full of nonsense? (http://www.kuro5hin.org/story/2001/9/24/43858/2479)", September 24, 2001.
56. ^ Joi Ito, "Wikipedia attacked by ignorant reporter (http://joi.ito.com/archives/2004/08/29/wikipedia_attacked_by_ignorant_reporter.html#c014592)", Joi Ito's Web, August 29, 2004.
57. ^ Cited by Workers World (http://www.workers.org/ww/2005/tsunami0113.php) (January 8, 2005) and Chicago Times (January 16, 2005)
58. ^ "Wikipedia:Replies to common objections (http://en.wikipedia.org/wiki/Wikipedia:Replies_to_common_objections)", Wikipedia, 22:53 April 13, 2005.
59. ^ "Critical views of Wikipedia (http://www.wikinfo.org/wiki.php?title=Critical_views_of_Wikipedia)", Wikinfo, 07:28 March 30, 2005.
60. ^ Andrew Orlowski, "Wiki-fiddlers defend Clever Big Book (http://www.theregister.co.uk/2004/07/23/wiki_fiddlers_big_book/)", The Register, July 23, 2004.
61. ^ Arthur, Charles. "Log on and join in, but beware the web cults (http://technology.guardian.co.uk/opinion/story/0,16541,1667346,00.html)", *The Guardian*, 2005-12-15.
62. ^ Lu Stout, Kristie. "Wikipedia: The know-it-all Web site (http://www.cnn.com/2003/TECH/internet/08/03/wikipedia/index.html)", *CNN*, 2003-08-04.
63. ^ Thompson, Bill. "What is it with Wikipedia? (http://news.bbc.co.uk/1/hi/technology/4534712.stm)", *BBC*, 2005-12-

16.
64. ^ Orlowski, Andrew. "Who owns your Wikipedia bio? (http://www.theregister.co.uk/2005/12/06/wikipedia_bio/)", *The Register*, 2005-12-06.
65. ^ "Wikipedia:Researching with Wikipedia (http://en.wikipedia.org/wiki/Wikipedia:Researching_with_Wikipedia)", Wikipedia (March 28, 2005).
66. ^ Professor James Fetzer Exposes Wikipedia.org (http://video.google.com/videoplay?docid=-1683057245164550824&q=fetzer)
67. ^ Wikipedia: "A Work in Progress" (http://www.businessweek.com/technology/content/dec2005/tc20051214_441708.htm) December 14, 2005.
68. ^ "Wikipedia:Provenance (http://en.wikipedia.org/wiki/Wikipedia:Provenance)", Wikipedia (May 9, 2006).
69. ^ Cross, Tom. "Puppy smoothies: Improving the reliability of open, collaborative Wikis" (http://www.firstmonday.org/issues/issue11_9/cross/index.html). First Monday.
70. ^ Aaron Krowne, "The FUD-based Encyclopedia (http://www.freesoftwaremagazine.com/free_issues/issue_02/fud_based_encyclopedia/)", Free Software Magazine, March 1, 2005.
71. ^ "Trophy Box (http://meta.wikimedia.org/wiki/Trophy_box)", Meta-Wiki (March 28, 2005).
72. ^ "Webby Awards 2004 (http://www.webbyawards.com/webbys/winners-2004.php)"
73. ^ "Jimmy Wales in Time 100 (http://www.time.com/time/magazine/article/0,9171,1187286,00.html)", TIME, 08:58 December 18, 2006.
74. ^ "[Nederlandse Wikipedia groeit als kool (http://www.multiscope.nl/organisatie/nieuws/sberichten/nederlandse-wikipedia-groeit-als-kool.html)] (Website in Dutch Language), Recovered December 27, 2006
75. ^ Bourgeois *et al* v. Peters *et al.* (http://www.ca11.uscourts.gov/opinions/ops/200216886.pdf)
76. ^ ;;;"C-38 (http://www.parl.gc.ca/LEGISINFO/index.asp?Lang=E&Chamber=C&StartList=2&EndList=200&Session=13&Type=0&Scope=I&query=4381&List=toc)", LEGISINFO (March 28, 2005)
77. ^ Wikipedia as a source (http://en.wikipedia.org/wiki/Wikipedia:Wikipedia_as_a_source)

Further reading

- Wikipedia:Introduction
- Wikipedia:FAQ
- Wikipedia:Wikipedia in academic studies
- Wikipedia:Press releases
- Wikipedia:Press coverage
- Wikipedia:Why Wikipedia is not so great
- Wikipedia:Replies to common objections
- Wikipedia:Improving Wikipedia
- Wikipedia:Statistics

External links

Links to content created under a Wikimedia Foundation project

- wikipedia.org (http://www.wikipedia.org/), multi-lingual portal
  - en.wikipedia.org (http://en.wikipedia.org/), English language edition
- Meta-Wiki (http://meta.wikipedia.org/), policy-related and technical discussions regarding Wikimedia
- Wikimedia Foundation (http://www.wikimediafoundation.org/), parent organization of Wikipedia
- Wikipedia Signpost (http://en.wikipedia.org/wiki/Wikipedia:Wikipedia_Signpost), English Wikipedia community newsletter published weekly
- Sanger, Larry, Origins of Wikipedia (http://en.wikipedia.org/w/index.php?title=User:Larry_Sanger/Origins_of_Wikipedia&oldid=39843351), essay within Sanger's English Wikipedia user page, wiki revision of 16 February 2006
- The Main Page (http://www.en.wikipedia.org/wiki/Main_Page) of English-language Wikipedia at various times:
  - Main Page on (http://nostalgia.wikipedia.org/wiki/HomePage) 20 December 2001, from nostalgia.wikipedia.org

- Main Page on (http://web.archive.org/web/20021010105340/www.wikipedia.org/wiki/Main_Page) 10 December 2002, from the Internet Archive Wayback Machine
- Main Page on (http://web.archive.org/web/20031202163536/en2.wikipedia.org/wiki/Main_Page) 2 December 2003, from the Internet Archive Wayback Machine

Overviews

- Wikipedia (http://dmoz.org/Computers/Open_Source/Open_Content/Encyclopedias/Wikipedia/) at the Open Directory Project
- Wikipedia (http://www.sourcewatch.org/index.php?title=Wikipedia) at SourceWatch

Reports and news articles (chronological)

For an expanded list maintained by Wikipedia contributors, see Wikipedia:Press coverage

- Meyers, Peter, Fact-Driven? Collegial? This Site Wants You (http://tech2.nytimes.com/mem/technology/techreview.html?res=9800E5D6123BF933A1575AC0A9679C8B63), New York Times 20 September 2001
- Viegas, Fernanda B., Martin Wattenberg, and Kushal Dave, "Studying Cooperation and Conflict between Authors with *history flow* Visualizations (http://web.media.mit.edu/~fviegas/papers/history_flow.pdf)", CHI 2004 April 24 – April 29, 2004. Preliminary report "History Flow (http://researchweb.watson.ibm.com/history/)" available on the IBM website.
- Udell, Jon, Heavy metal umlaut: the movie (http://weblog.infoworld.com/udell/2005/01/22.html), screencast illustrating the editing process on a selected Wikipedia article, 22 January 2005
- Sanger, Larry, The Early History of Nupedia and Wikipedia: A Memoir (http://features.slashdot.org/article.pl?sid=05/04/18/164213), from Slashdot and *Open Sources 2.0*, 18 April 2005
- Worldwide Wikimania (http://www.guardian.co.uk/online/story/0,3605,1546162,00.html), The Guardian, 11 August 2005
- Interview with Jimmy Wales, CEO of WikiPedia (http://www.npost.com/interview.jsp?intID=INT00126)," nPost, November 1, 2005
- Seigenthaler, John, Sr., "A false Wikipedia 'biography'" (http://www.usatoday.com/news/opinion/editorials/2005-11-29-wikipedia-edit_x.htm), *USA Today*, 29 November 2005
- Giles, Jim, Internet encyclopaedias go head to head (http://www.nature.com/news/2005/051212/pf/438900a_pf.html), *Nature* comparison between Wikipedia and Britannica, 14 December 2005
  - Fatally Flawed: Refuting the recent study on encyclopedic accuracy by the journal *Nature* (http://corporate.britannica.com/britannica_nature_response.pdf), Encyclopedia Britannica Inc., March 2006
  - *Nature's* responses to Encyclopaedia Britannica (http://www.nature.com/nature/britannica/index.html), *Nature*, 23 March 2006
- Berinstein, Paula, "Wikipedia and *Britannica*: The Kid's All Right (And So's the Old Man)" (http://www.infotoday.com/searcher/mar06/berinstein.shtml), *Searcher* Vol. 14 No. 3, March 2006
- Vaknin, Sam, The Six Sins of the Wikipedia (http://www.yoursdaily.com/culture_media/media/the_future_of_wikipedia), *YoursDaily.com*, 7 April 2006
- Sjöberg, Lore, The Wikipedia FAQK (http://www.wired.com/news/columns/0,70670-0.html?tw=wn_index_3/), Wired News, 19 April 2006
- Rosenzweig, Roy, Can History be Open Source? Wikipedia and the Future of the Past (http://chnm.gmu.edu/resources/essays/d/42), *Journal of American History*, Volume 93, Number 1 (June, 2006): 117-46
- Growing Wikipedia Refines Its 'Anyone Can Edit' Policy (http://www.nytimes.com/2006/06/17/technology/17wiki.html?ei=5088&en=646c3d018ce68f36&ex=1308196800&adxnnl=1&partner=rssnyt&emc=rss&adxnnlx=11632(-dH99FAIMlAPTkMHs6g+OlQ) The New York Times (June 17, 2006)

- Schiff, Stacy, Know It All: Can Wikipedia conquer expertise? (http://www.newyorker.com/printables/fact/060731fa_fact), The New Yorker, July 31, 2006
- Levine, Robert, "The Many Voices of Wikipedia, Heard in One Place (http://www.nytimes.com/2006/08/07/technology/07wiki.html?_r=1&oref=slogin)", New York Times, 7 August 2006
- Poe, Marshall, The Hive (http://www.theatlantic.com/doc/200609/wikipedia), The Atlantic Monthly, September 2006
- Pearson, Helen, Textbook free for all (http://www.nature.com/news/2006/060911/full/060911-13.html), Nature, 15 September 2006
- Hubbard, John, Why Wiki? (http://www.uwm.edu/Libraries/courses/wiki/), a library video course on Wikipedia, October 10, 2006
- Kirschner, Ann, Adventures in the Land of Wikipedia, (http://chronicle.com/free/v53/i13/13b01001.htm) from the November 17 2006 issue of The Chronicle of Higher Education.

Other

- Uncyclopedia (http://www.uncyclopedia.org/): Uncyclopedia, a satirical parody of Wikipedia
- WiKP (http://www.wikp.com/): WiKP, a Google-based Wikipedia search engine

Retrieved from "http://en.wikipedia.org/wiki/Wikipedia"

Categories: Articles with unsourced statements | Semi-protected | Articles with sections needing expansion | Spoken articles | 2001 establishments | Free encyclopedias | Online encyclopedias | Wikipedia | Wikimedia projects | Web 2.0 | Virtual communities | Advertising-free websites | General encyclopedias

- This page was last modified 14:59, 27 December 2006.
- All text is available under the terms of the GNU Free Documentation License. (See **Copyrights** for details.) Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc.

Exhibit 14

IEEE Std 100-1992

The New IEEE Standard Dictionary of Electrical and Electronics Terms

[Including Abstracts of All Current IEEE Standards]

Fifth Edition

Gediminas P. Kurpis, Chair

Christopher J. Booth, Editor

IEEE

IEEE

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1993 by the
Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 1993
Printed in the United States of America

ISBN 1-55937-240-0

*No part of this publication may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.*

January 15, 1993 SH15594

recording medium to another section of the same medium when these sections are brought into proximity. *Note:* The resulting copy usually is distorted. [32]

priority (1) (computer graphics). A segment attribute that determines which of several overlapping segments is closer to the viewer. 610.6-1991
(2) (software). The level of importance assigned to an item. 610.12-1990
(3) (multiprocessor architectures). A bus request protocol in which the module with the highest arbitration number acquires the bus. 896.1-1987
(4) (use in primitives). A parameter used to convey the priority required or desired. 8802-2:1989

priority interrupt. An interrupt performed to permit execution of a process that has a higher priority than the process currently executing. 610.12-1990

priority interrupt bus. One of the four buses provided by the backplane. The priority interrupt bus allows interrupter modules to send interrupt requests to interrupt-handler modules. 1014-1987

priority queue. A list to which items may be appended to or retrieved from any position, depending on some property of the item being added or removed. *Note:* This data structure is misnamed in that it contradicts the definition of queue. 610.5-1990

priority string (power-system communication). A series connection of logic circuits such that inputs are accommodated in accordance with their position in the string, one end of the string corresponding to the highest priority. *See:* **digital.** [123]

privacy system (radio transmission). A system designed to make unauthorized reception difficult. *See:* **radio transmission.** [119]

private. A design feature intended solely for use by the component manufacturer. 1149.1-1990

private automatic branch exchange (PABX) (telephone switching systems) (data transmission). A private branch exchange that is automatic. 312-1977w, 599-1985w

private automatic exchange (PAX) (telephone switching systems) (data transmission). A private nonbranch exchange that is automatic. 312-1977w, 599-1985w

private branch exchange (PBX) (telephone switching systems) (data transmission). A private telecommunications exchange that includes access to a public telecommunications exchange. 312-1977w, 599-1985w

private branch exchange hunting (telephone switching systems). An arrangement for searching over a group of trunks at the central office, any one of which would provide a connection to the desired private branch exchange. 312-1977w

private-branch-exchange trunk (PBX) (telephone switching systems). A line used as a trunk between a private branch exchange and the central office that serves it. 312-1977w

private exchange. A telephone exchange serving a single organization and having no means for connection with a public telephone exchange. [28], [48]

private line (private wire) (data transmission). A channel or circuit furnished to a subscriber for the subscriber's exclusive use. 599-1985w

private line telegraph network (data transmission). A system of points interconnected by leased telegraph channels and providing hard-copy or five-track punched paper tape, or both, at both sending and receiving points. 599-1985w

private line telephone network (data transmission). A series of points interconnected by leased voice-grade telephone lines, with switching facilities or exchange operated by the customer. 599-1985w

private non-branch exchange (telephone switching systems). A series of points interconnected by leased voice-grade telephone lines, with switching facilities or exchange operated by the customer. [123]

private residence. A separate dwelling or a separate apartment in a multiple dwelling that is occupied only by the members of a single family unit. [119]

private residence elevator. A power passenger electric elevator, installed in a private residence, and that has a rated load not in excess of 700 pounds, a rated speed not in excess of 50 feet per minute, a net inside platform area not in excess of 12 square feet, and a rise not in excess of 50 feet. *See:* **elevators.** [119]

private-residence inclined lift. A power passenger lift, installed on a stairway in a private residence, for raising and lowering persons from one floor to another. *See:* **elevator.** [119]

private telecommunication exchange (telephone switching systems). A telecommunications exchange for a single organization. 312-1977w

private telephone network. A telephone network set up solely to meet the requirements of the particular organization. 823-1989

private type. A data type whose structure and possible values are defined but are not revealed to the user of the type. *See also:* **information hiding.** 610.12-1990

privileged instruction (software). A computer instruction that can be executed only by a supervisory program. 610.12-1990

Exhibit 15

#1 SELLING
Telecommunications
Dictionary

FOURTH EDITION

DOES NOT CIRCULATE

DO NOT REMOVE FROM
BOSTON LIBRARY

Newton's TELECOM dictionary

THE OFFICIAL GLOSSARY OF TELECOMMUNICATIONS AND
COMPUTER ACRONYMS, TERMS AND JARGON

by Harry Newton

NEWTON'S TELECOM DICTIONARY

Published by Telecom Library Inc.
Telecom Library publishes books and magazines and runs seminars on telephones, telecommunications, local area networks, data communications software and hardware. It also distributes the books of other publishers, making it the "central source" for all the above materials. Call or write for your **FREE** catalog.

Other Books by Telecom Library
The TELECOM LIBRARY Guide to
- T-1 Networking
- Negotiating Telecommunications Contracts
- Buying Short Haul Microwave
- The Guide to Frame Relay
- The Inbound Telephone Call Center
- SONET: Planning, Installing & Maintaining Broadband Networks

The TELECONNECT Guide to
- Automatic Call Distributors
- The Business of Interconnect
- How to Sell Call Accounting Systems
- Professional Selling

and...
- 101 Money-Saving Secrets Your Phone Company Won't Tell You
- Frames, Packets and Cells in Broadband Networking
- Profit and Control Through Call Accounting
- Telecommunications Management for Business and Government
- The Dictionary of Sales and Marketing Technology Terms
- Which Phone System Should I Buy?

FREE Catalog of Books
Telecom Library publishes books itself, and also distributes the books of every other telecommunications publisher.
You may receive your **FREE** copy of our latest catalog by calling 212-691-8215, or by dropping a line to the Christine Fullam, Telecom Library Manager, at the address below.
You may order your Telecom Library books by calling 1-800-LIBRARY or 1-800-999-0345; or fax your order to 212-691-1191.

Quantity Purchases
If you wish to purchase this book, or any others, in quantity, please contact:

Christine Fullam, Manager
Telecom Library Inc.
12 West 21 Street
New York, NY 10010
1-800-LIBRARY or 212-691-8215
Facsimile orders: 212-691-1191

Copyright 1991©, Telecom Library Inc. All rights reserved. This book was designed and produced by Randi Ripley and Jennifer Cooper-Farrow, Telecom Library. Printed in USA at BookCrafters, Chelsea, MI ISBN 0-936648-29-5

Telecom Library Inc., 12 West 21 Street, New York, NY 10010
212-691-8215 1-800-LIBRARY

PRIORITIZATION The process of assigning different values to network users, such that a user with higher priority will be offered access or service before a user with lower priority. Increasingly available as an added option with network operation. Any procedure where different levels of precedence exist.

PRIORITY A ranking given to a task which determines when it will be processed.

PRIORITY BUMPING The process during a link, trunk or facility failure where lower priority user access to network services is interrupted in order to offer those services or bandwidth to a predesignated higher priority user.

PRIORITY CALL Emergency calls to the attendant bypass the normal queue and alert the attendant with some special signal.

PRIORITY INDICATOR A character or group of characters which determine the position in queue of the message in relation to the urgency of other messages. Priority indicators control the order in which messages are to be delivered.

PRIORITY RINGING A name for a Pacific Bell (and possibly other local telephone companies') service which alerts you to have calls from selected numbers ring at another number.

PRIORITY TRANSPORT The capability of a network for certain classes of traffic to have priority over others and thus have lower delay or otherwise better performance.

PRIORITY TRUNK QUEUING Through user-chosen trunk access level, this PBX feature places any caller with this or higher level in the class of service assignment ahead of callers waiting for the same trunk group (or Agent Group in the case of incoming ACD calls).

PRIVATE AUTOMATIC BRANCH EXCHANGE See PABX.

PRIVATE BRANCH EXCHANGE See PBX.

PRIVATE NETWORKS MARKETING A Northern Telecom term which defines their organization for making and selling all telecom switches, except central offices. These products include the Meridian 1 PBX family, residential and business telephone sets, including Norstar and data communications.

PRIVACY Privacy usually means that once a caller "seizes" a line, no other user can access that same line even though it appears on his/her key set. Privacy can be automatic or selected for each call.

PRIVACY AND PRIVACY RELEASE All other extensions of a line are unable to enter a conversation in progress unless the initiating telephone releases the feature.

PRIVACY LOCKOUT Privacy automatically splits the connection whenever an attendant would otherwise be included on the call, i.e. the attendant can't listen in to a call she's just extended to someone. A tone warning is generated when the attendant bridges into a conversation in progress.

REM 0086631

<u>Exhibit 16</u>

Case 2:07-cv-00498-FMC-FE Document 1-3 Filed 06/28/2007 Page 2 of 9

OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection

HUBERT ZIMMERMANN

(Invited Paper)

Abstract—Considering the urgency of the need for standards which would allow constitution of heterogeneous computer networks, ISO created a new subcommittee for "Open Systems Interconnection" (ISO/TC97/SC16) in 1977. The first priority of subcommittee 16 was to develop an architecture for open systems interconnection which could serve as a framework for the definition of standard protocols. As a result of 18 months of studies and discussions, SC16 adopted a layered architecture comprising seven layers (Physical, Data Link, Network, Transport, Session, Presentation, and Application). In July 1979 the specifications of this architecture, established by SC16, were passed under the name of "OSI Reference Model" to Technical Committee 97 "Data Processing" along with recommendations to start officially, on this basis, a set of protocols standardization projects to cover the most urgent needs. These recommendations were adopted by TC97 at the end of 1979 as the basis for the following development of standards for Open Systems Interconnection within ISO. The OSI Reference Model was also recognized by CCITT Rapporteur's Group on "Layered Model for Public Data Network Services."

This paper presents the model of architecture for Open Systems Interconnection developed by SC16. Some indications are also given on the initial set of protocols which will likely be developed in this OSI Reference Model.

I. INTRODUCTION

IN 1977, the International Organization for Standardization (ISO) recognized the special and urgent need for standards for heterogeneous informatic networks and decided to create a new subcommittee (SC16) for "Open Systems Interconnection."

The initial development of computer networks had been fostered by experimental networks such as ARPANET [1] or CYCLADES [2], immediately followed by computer manufacturers [3], [4]. While experimental networks were conceived as heterogeneous from the very beginning, each manufacturer developed his own set of conventions for interconnecting his own equipments, referring to these as his "network architecture."

The universal need for interconnecting systems from different manufacturers rapidly became apparent [5], leading ISO to decide for the creation of SC16 with the objective to come up with standards required for "Open Systems Interconnection." The term "open" was chosen to emphasize the fact that by conforming to those international standards, a system will be open to all other systems obeying the same standards throughout the world.

The first meeting of SC16 was held in March 1978, and initial discussions revealed [6] that a consensus could be reached rapidly on a layered architecture which would satisfy most requirements of Open Systems Interconnection with the capacity of being expanded later to meet new requirements. SC16 decided to give the highest priority to the development of a standard Model of Architecture which would constitute the framework for the development of standard protocols. After less than 18 months of discussions, this task was completed, and the ISO Model of Architecture called the Reference Model of Open Systems Interconnection [7] was transmitted by SC16 to its parent Technical Committee on "Data Processing" (TC97) along with recommendations to officially start a number of projects for developing on this basis an initial set of standard protocols for Open Systems Interconnection. These recommendations were adopted by TC97 at the end of 1979 as the basis for following development of standards for Open Systems Interconnection within ISO. The OSI Reference Model was also recognized by CCITT Rapporteur's Group on Public Data Network Services.

The present paper describes the OSI Architecture Model as it has been transmitted to TC97. Sections II–V introduce concepts of a layered architecture, along with the associated vocabulary defined by SC16. Specific use of those concepts in the OSI seven layers architecture are then presented in Section VI. Finally, some indications on the likely development of OSI standard protocols are given in Section VII.

Note on an "Interconnection Architecture"

The basic objective of SC16 is to standardize the rules of interaction between interconnected systems. Thus, only the external behavior of Open Systems must conform to OSI Architecture, while the internal organization and functioning of each individual Open System is out of the scope of OSI standards since these are not visible from other systems with which it is interconnected [8].

It should be noted that the same principle of restricted visibility is used in any manufacturer's network architecture in order to permit interconnection of systems with different structures within the same network.

These considerations lead SC16 to prefer the term of "Open Systems Interconnection Architecture" (OSIA) to the term of "Open Systems Architecture" which had been used previously and was felt to be possibly misleading. However, for unclear reasons, SC16 finally selected the title "Reference Model of Open Systems Interconnection" to refer to this Interconnection Architecture.

Manuscript received August 5, 1979; revised January 16, 1980.
The author is with IRIA/Laboria, Rocquencourt, France.

0090-6778/80/0400-0425$00.75 © 1980 IEEE

REM 0086902

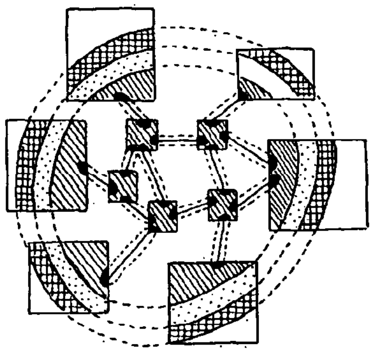


Fig. 1. Network layering.

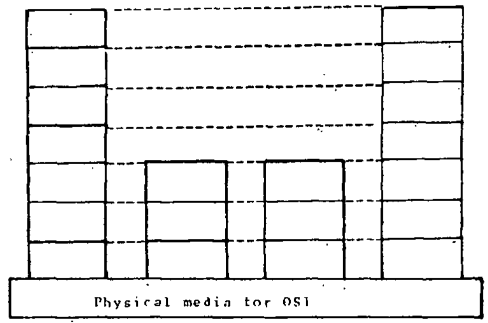


Fig. 2. An example of OSI representation of layering.

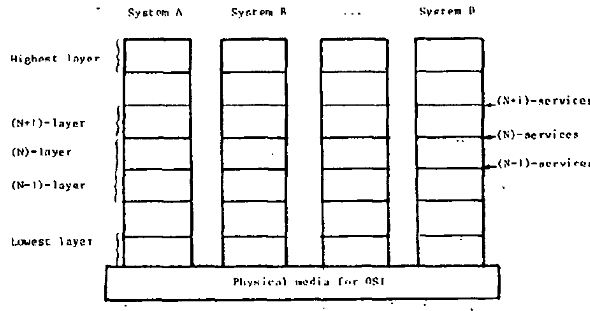


Fig. 3. Systems, layers, and services.

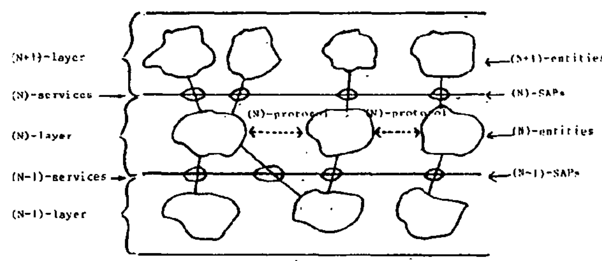


Fig. 4. Entities, service access points (SAP's), and protocols.

II. GENERAL PRINCIPLES OF LAYERING

Layering is a structuring technique which permits the network of Open Systems to be viewed as logically composed of a succession of layers, each wrapping the lower layers and isolating them from the higher layers, as exemplified in Fig. 1.

An alternative but equivalent illustration of layering, used in particular by SC16 is given in Fig. 2 where successive layers are represented in a vertical sequence, with the physical media for Open Systems Interconnection at the bottom.

Each individual system itself is viewed as being logically composed of a succession of subsystems, each corresponding to the intersection of the system with a layer. In other words, a layer is viewed as being logically composed of subsystems of the same rank of all interconnected systems. Each subsystem is, in turn, viewed as being made of one or several entities. In other words, each layer is made of entities, each of which belongs to one system. Entities in the same layer are termed *peer* entities.

For simplicity, any layer is referred to as the (N) *layer*, while its next lower and next higher layers are referred to as the $(N - 1)$ layer and the $(N + 1)$ layer, respectively. The same notation is used to designate all concepts relating to layers, e.g., entities in the (N) layer are termed (N) *entities*, as illustrated in Figs. 3 and 4.

The basic idea of layering is that each layer adds value to services provided by the set of lower layers in such a way that the highest layer is offered the set of services needed to run distributed applications. Layering thus divides the total problem into smaller pieces. Another basic principle of layering is to ensure independence of each layer by defining services provided by a layer to the next higher layer, independent of how these services are performed. This permits changes to be made in the way a layer or a set of layers operate, provided they still offer the same service to the next higher layer. (A more comprehensive list of criteria for layering is given in Section VI.) This technique is similar to the one used in structured programming where only the functions performed by a module (and not its internal functioning) are known by its users.

Except for the highest layer which operates for its own purpose, (N) entities distributed among the interconnected Open Systems work collectively to provide the (N) *service* to $(N + 1)$ entities as illustrated in Fig. 4. In other words, the (N) entities add value to the $(N - 1)$ service they get from the $(N - 1)$ layer and offer this value-added service, i.e., the (N) service to the $(N + 1)$ entities.

Communication between the $(N + 1)$ entities make exclusive use of the (N) services. In particular, direct communication between the $(N + 1)$ entities in the same system, e.g., for sharing resources, is not visible from outside of the system and thus is not covered by the OSI Architecture. Entities in the lowest layer communicate through the Physical Media for OSI, which could be considered as forming the (O) layer of the OSI Architecture. Cooperation between the (N) entities is ruled by the (N) *protocols* which precisely define how the (N) entities work together using the $(N - 1)$ services to perform the (N) functions which add value to the $(N - 1)$ service in order to offer the (N) service to the $(N + 1)$ entities.

The (N) services are offered to the $(N + 1)$ entities at the (N) *service access points*, or (N) *SAP's* for short, which represent the logical interfaces between the (N) entities and the $(N + 1)$ entities. An (N) SAP can be served by only one

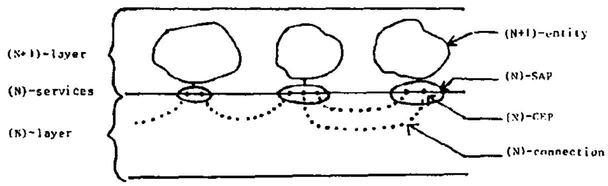


Fig. 5. Connections and connection endpoints (CEP's).

(*N*) entity and used by only one ($N + 1$) entity, but one (*N*) entity can serve several (*N*)SAP's and one($N + 1$) entity can use several (*N*) SAP's.

A common service offered by all layers consists of providing associations between peer SAP's which can be used in particular to transfer data (it can, for instance, also be used to synchronize the served entities participating in the association). More precisely (see Fig. 5), the (*N*) layer offers (*N*) *connections* between (*N*) SAP's as part of the (*N*) services. The most usual type of connection is the *point-to-point* connection, but there are also *multiendpoint* connections which correspond to multiple associations between entities (e.g., broadcast communication). The end of an (*N*) connection at an (*N*) SAP is called an (*N*) *connection endpoint* or (*N*) *CEP* for short. Several connections may coexist between the same pair (or *n*-tuple) of SAP's.

Note: In the following, for the sake of simplicity, we will consider only point-to-point connections.

III. IDENTIFIERS

Objects within a layer or at the boundary between adjacent layers need to be uniquely identifiable, e.g., in order to establish a connection between two SAP's, one must be able to identify them uniquely. The OSI Architecture defines identifiers for entities, SAP's, and connections as well as relations between these identifiers, as briefly outlined below.

Each (*N*) entity is identified with a *global title*[1] which is unique and identifies the same (*N*) entity from anywhere in the network of Open Systems. Within more limited *domains*, an (*N*) entity can be identified with a *local title* which uniquely identifies the (*N*) entity only in the domain. For instance, within the domain corresponding to the (*N*) layer, (*N*) entities are identified with (*N*) *global titles* which are unique within the (*N*) layer.

Each (*N*) SAP is identified with an (*N*) *address* which uniquely identifies the (*N*)-SAP at the boundary between the (*N*) layer and the ($N + 1$) layer.

The concepts of titles and addresses are illustrated in Fig. 6.

Binding between (*N*) entities and the ($N - 1$) SAP's they use (i.e., SAP's through which they can access each other and communicate) are translated into the concept of (*N*) directory which indicates correspondence between global titles of (*N*) entities and (*N*) addresses through which they can be reached, as illustrated in Fig. 7.

[1] The term "title" has been preferred to the term "name" which is viewed as bearing a more general meaning. A title is equivalent to an entity name.

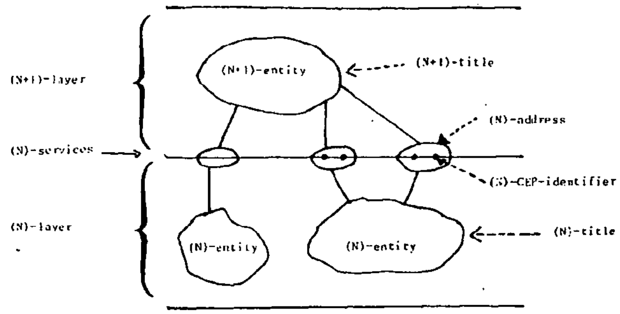


Fig. 6. Titles, addresses, and CEP-identifiers.

(N)-title	(N-1)-address
A	352
B	237
B	015
C	015

Fig. 7. Example of an (*N*)-directory.

Correspondence between (*N*) addresses served by an (*N*) entity and the ($N - 1$) addresses used for this purpose is performed by an (*N*) mapping function. In addition to the simplest case of one-to-one mapping, mapping may, in particular, be hierarchical with the (*N*) address being made of an ($N - 1$) address and an (*N*) suffix. Mapping may also be performed "by table." Those three types of mapping are illustrated in Fig. 8.

Each (*N*) CEP is uniquely identified within its (*N*) SAP by an (*N*) *CEP identifier* which is used by the (*N*) entity and the ($N + 1$) entity on both sides of the (*N*) SAP to identify the (*N*) connection as illustrated in Fig. 6. This is necessary since several (*N*) connections may end at the same (*N*) SAP.

IV. OPERATION OF CONNECTIONS

A. Establishment and Release

When an ($N + 1$) entity requests the establishment of an (*N*) connection from one of the (*N*) SAP's it uses to another (*N*) SAP, it must provide at the local (*N*) SAP the (*N*) address of the distant (*N*) SAP. When the (*N*) connection is established, both the ($N + 1$) entity and the (*N*) entity will use the (*N*)CEP identifier to designate the (*N*) connection.

(*N*) connections may be established and released dynamically on top of ($N - 1$) connections. Establishment of an (*N*) connection implies the availability of an ($N - 1$) connection between the two entities. If not available, the ($N - 1$) connection must be established. This requires the availability of an ($N - 2$) connection. The same consideration applies downwards until an available connection is encountered.

In some cases, the (*N*) connection may be established simultaneously with its supporting ($N - 1$) connection provided

REM 0086904

Case 2:07-cv-00398-TJW-CE Document 193-17 Filed 06/28/2007 Page 55 of 99

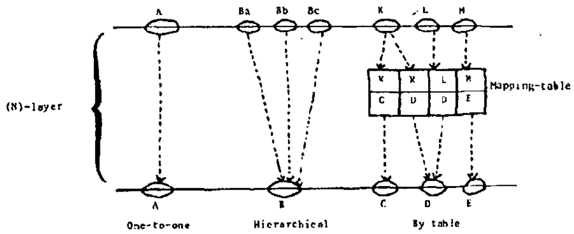


Fig. 8. Mapping between addresses.

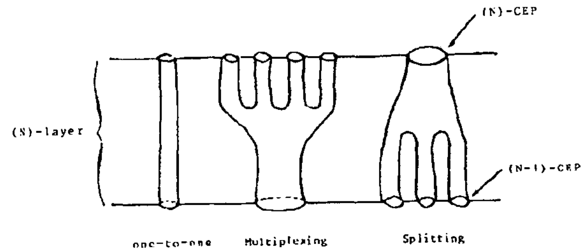


Fig. 9. Correspondence between connections.

the $(N-1)$ connection establishment service permits (N) entities to exchange information necessary to establish the (N) connection.

B. Multiplexing and Splitting

Three particular types of construction of (N) connections on top of $(N-1)$ connections are distinguished.

1) One-to-one correspondence where each (N) connection is built on one $(N-1)$ connection.

2) Multiplexing (referred to as "upward multiplexing" in [7]) where several (N) connections are multiplexed on one single $(N-1)$ connection.

3) Splitting (referred to as "downward multiplexing" in [7]) where one single (N) connection is built on top of several $(N-1)$ connection, the traffic on the (N) connection being divided between the various $(N-1)$ connections.

These three types of correspondence between connections in adjacent layers are illustrated in Fig. 9.

C. Data Transfer

Information is transferred in various types of data units between peer entities and between entities attached to a specific service access point. The data units are defined below and the interrelationship among several of them is illustrated in Fig. 10.

(N) *Protocol Control Information* is information exchanged between two (N) entities, using an $(N-1)$ connection, to coordinate their joint operation.

(N) *User Data* is the data transferred between two (N) entities on behalf of the $(N+1)$ entities for whom the (N) entities are providing services.

An (N) *Protocol Data Unit* is a unit of data which contains (N) Protocol Control Information and possibly (N) User Data.

(N) *Interface Control Information* is information exchanged between an $(N+1)$ entity and an (N) entity to coordinate their joint operation.

(N) *Interface Data* is information transferred from an $(N+1)$ entity to an (N) entity for transmission to a correspondent $(N+1)$ entity over an (N) connection, or conversely, information transferred from an (N) entity to an $(N+1)$ entity which has been received over an (N) connection from a correspondent $(N+1)$ entity.

(N) *Interface Data Unit* is the unit of information transferred across the service access point between an $(N+1)$ entity and an (N) entity in a single interaction. The size of (N) interface data units is not necessarily the same at each end of the connection.

	Control	Data	Combined
(N) - (N) Peer Entities	(N)-Protocol-Control-Information	(N)-User-Data	(N)-Protocol-Data-Units
(N)-(N-1) Adjacent layers	(N-1)-Interface-Control-Information	(N-1)-Interface Data	(N-1)-Interface Data-Unit

Fig. 10. Interrelationship between data units.

$(N-1)$ *Service Data Unit* is the amount of $(N-1)$ interface data whose identity is preserved from one end of an $(N-1)$ connection to the other. Data may be held within a connection until a complete service data unit is put into the connection.

Expedited $(N-1)$ service data unit is a small $(N-1)$ service data unit whose transfer is expedited. The $(N-1)$ layer ensures that an expedited data unit will not be delivered after any subsequent service data unit or expedited data unit sent on that connection. An expedited $(N-1)$ service data unit may also be referred to as an $(N-1)$ expedited data unit.

Note: An (N) protocol data unit may be mapped one-to-one onto an $(N-1)$ service data unit (see Fig. 11).

V. MANAGEMENT ASPECTS

Even though a number of resources are managed locally, i.e., without involving cooperation between distinct systems, some management functions do.

Examples of such management functions are

configuration information,
cold start/termination,
monitoring,
diagnostics,
reconfiguration, etc.

The OSI Architecture considers management functions as applications of a specific type. Management entities located in the highest layer of the architecture may use the complete set of services offered to all applications in order to perform

REM 0086905

Case 2:07-cv-00439-TJW-CE Document 193-17 Filed 06/28/2007 Page 6 of 9

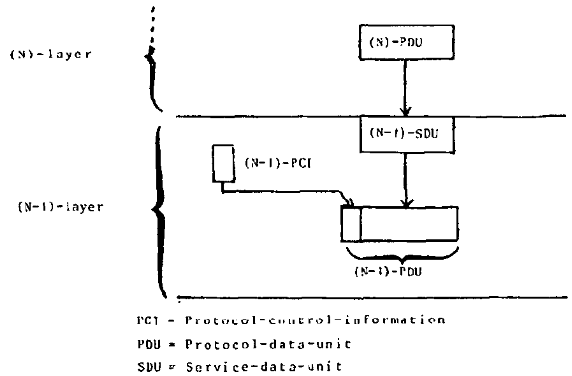


Fig. 11. Logical relationship between data units in adjacent layers.

management functions. This organization of management functions within the OSI Architecture is illustrated in Fig. 12.

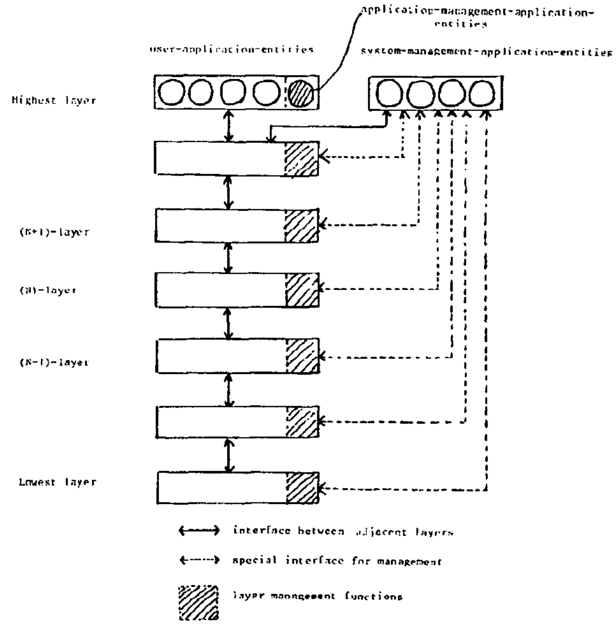


Fig. 12. A representation of management functions.

VI. THE SEVEN LAYERS OF THE OSI ARCHITECTURE

A. Justification of the Seven Layers

ISO determined a number of principles to be considered for defining the specific set of layers in the OSI architecture, and applied those principles to come up with the seven layers of the OSI Architecture.

Principles to be considered are as follows.

1) Do not create so many layers as to make difficult the system engineering task describing and integrating these layers.

2) Create a boundary at a point where the services description can be small and the number of interactions across the boundary is minimized.

3) Create separate layers to handle functions which are manifestly different in the process performed or the technology involved.

4) Collect similar functions into the same layer.

5) Select boundaries at a point which past experience has demonstrated to be successful.

6) Create a layer of easily localized functions so that the layer could be totaly redesigned and its protocols changed in a major way to take advantages of new advances in architectural, hardware, or software technology without changing the services and interfaces with the adjacent layers.

7) Create a boundary where it may be useful at some point in time to have the corresponding interface standardized.

8) Create a layer when there is a need for a different level of abstraction in the handling of data, e.g., morphology, syntax, semantics.

9) Enable changes of functions or protocols within a layer without affecting the other layers.

10) Create for each layer interfaces with its upper and lower layer only.

11) Create further subgrouping and organization of functions to form sublayers within a layer in cases where distinct communication services need it.

12) Create, where needed, two or more sublayers with a common, and therefore minimum, functionality to allow interface operation with adjacent layers.

13) Allow bypassing of sublayers.

B. Specific Layers

The following is a brief explanation of how the layers were chosen.

1) It is essential that the architecture permits usage of a realistic variety of physical media for interconnection with different control procedures (e.g., V.24, V.35, X.21, etc.). Application of principles 3, 5, and 8 leads to identification of a *Physical Layer* as the lowest layer in the architecture.

2) Some physical communications media (e.g., telephone line) require specific techniques to be used in order to transmit data between systems despite a relatively high error rate (i.e., an error rate not acceptable for the great majority of applications). These specific techniques are used in data-link control procedures which have been studied and standardized for a number of years. It must also be recognized that new physical communications media (e.g., fiber optics) will require different data-link control procedures. Application of principles 3, 5, and 8 leads to identification of a *Data link Layer* on top of the Physical Layer in the architecture.

3) In the Open Systems Architecture, some systems will act as final destination of data. Some systems may act only as intermediate nodes (forwarding data to other systems). Application of principles 3, 5, and 7 leads to identification of a *Network Layer* on top of the Data link Layer. Network-oriented protocols such as routing, for example, will be grouped in this layer. Thus, the Network Layer will provide a connection path (network connection) between a pair of transport entities (see Fig. 13).

4) Control of data transportation from source end system to destination end system (which need not be performed in

Case 2:07-cv-00398-TJW-CE Document 193-17 Filed 06/28/2007 Page 7 of 9

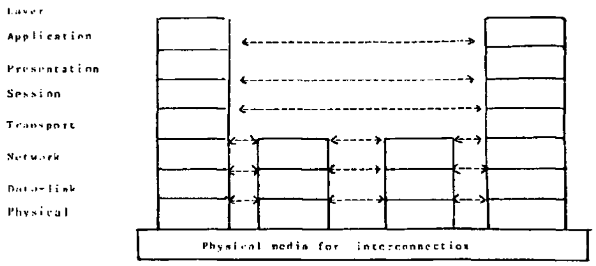


Fig. 13. The seven layers OSI architecture.

intermediate nodes) is the last function to be performed in order to provide the totality of the transport service. Thus, the upper layer in the transport-service part of the architecture is the *Transport Layer,* sitting on top of the Network Layer. This Transport Layer relieves higher layer entities from any concern with the transportation of data between them.

5) In order to bind/unbind distributed activities into a logical relationship that controls the data exchange with respect to synchronization and structure, the need for a dedicated layer has been identified. So the application of principles 3 and 4 leads to the establishment of the *Session Layer* which is on top of the Transport Layer.

6) The remaining set of general interest functions are those related to representation and manipulation of structured data for the benefit of application programs. Application of principles 3 and 4 leads to identification of a *Presentation Layer* on top of the Session Layer.

7) Finally, there are applications consisting of application processes which perform information processing. A portion of these application processes and the protocols by which they communicate comprise the *Application Layer* as the highest layer of the architecture.

The resulting architecture with seven layers, illustrated in Fig. 13 obeys principles 1 and 2.

A more detailed definition of each of the seven layers identified above is given in the following sections, starting from the top with the application layer described in Section VI-C1) down to the physical layer described in Section VI-C7).

C. Overview of the Seven Layers of the OSI Architecture

1) *The Application Layer*: This is the highest layer in the OSI Architecture. Protocols of this layer directly serve the end user by providing the distributed information service appropriate to an application, to its management, and to system management. Management of Open Systems Interconnection comprises those functions required to initiate, maintain, terminate, and record data concerning the establishment of connections for data transfer among application processes. The other layers exist only to support this layer.

An application is composed of cooperating *application processes* which intercommunicate according to application layer protocols. Application processes are the ultimate source and sink for data exchanged.

A portion of an application process is manifested in the application layer as the execution of application protocol (i.e., application entity). The rest of the application process is considered beyond the scope of the present layered model. Applications or application processes may be of any kind (manual, computerized, industrial, or physical).

2) *The Presentation Layer*: The purpose of the Presentation Layer is to provide the set of services which may be selected by the Application Layer to enable it to interpret the meaning of the data exchanged. These services are for the management of the entry exchange, display, and control of structured data.

The presentation service is location-independent and is considered to be on top of the Session Layer which provides the service of linking a pair of presentation entities.

It is through the use of services provided by the Presentation Layer that applications in an Open Systems Interconnection environment can communicate without unacceptable costs in interface variability, transformations, or application modification.

3) *The Session Layer*: The purpose of the Session Layer is to assist in the support of the interactions between cooperating presentation entities. To do this, the Session Layer provides services which are classified into the following two categories.

a) Binding two presentation entities into a relationship and unbinding them. This is called *session administration service.*

b) Control of data exchange, delimiting, and synchronizing data operations between two presentation entities. This is called *session dialogue service*.

To implement the transfer of data between presentation entities, the Session Layer may employ the services provided by the Transport Layer.

4) *The Transport Layer*: The Transport Layer exists to provide a universal transport service in association with the underlying services provided by lower layers.

The Transport Layer provides transparent transfer of data between session entities. The Transport Layer relieves these session entities from any concern with the detailed way in which reliable and cost-effective transfer of data is achieved.

The Transport Layer is required to optimize the use of available communications services to provide the performance required for each connection between session entities at a minimum cost.

5) *The Network Layer*: The Network Layer provides functional and procedural means to exchange network service data units between two transport entities over a network connection. It provides transport entities with independence from routing and switching considerations.

6) *The Data Link Layer*: The purpose of the Data link Layer is to provide the functional and procedural means to establish, maintain, and release data links between network entities.

7) *The Physical Layer*: The Physical Layer provides mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections (e.g., data circuits) between data link entities.

VII. OSI PROTOCOLS DEVELOPMENTS

The model of OSI Architecture defines the services provided by each layer to the next higher layer, and offers con-

REM 0086907

cepts to be used to specify how each layer performs its specific functions.

Detailed functioning of each layer is defined by the protocols specific to the layer in the framework of the Architecture model.

Most of the initial effort within ISO has been placed on the model of OSI. The next step consists of the definition of standard protocols for each layer.

This section contains a brief description of a likely initial set of protocols, corresponding to specific standardization projects recommended by SC16.

A. Protocols in the Physical Layer

Standards already exist within CCITT defining:

1) interfaces with physical media for OSI, and

2) protocols for establishing, controlling, and releasing switched data circuits.

Such standards are described in other papers in this issue [9], [10], e.g., X.21, V.24, V.35, etc.

The only work to be done will consist of clearly relating those standards to the OSI Architecture model.

B. Protocols in the Data Link Layer

Standard protocols for the Data link Layer have already been developed within ISO, which are described in other papers within this issue [11], [12].

The most popular Data link Layer protocol is likely to be HDLC [13], without ruling out the possibility of using also other character-oriented standards.

Just as for the Physical Layer, the remaining work will consist mainly of clearly relating these existing standards to the OSI Architecture model.

C. Protocols in the Network Layer

An important basis for protocols in the network layer is level 3 of the X.25 interface [14] defined by CCITT and described in another paper in this issue. It will have to be enhanced in particular to permit interconnection of private and public networks.

Other types of protocols are likely to be standardized later in this layer, and in particular, protocols corresponding to Datagram networks [10].

D. Protocols in the Transport Layer

No standard exists at present for this layer; a large amount of experience has been accumulated in this area and several proposals are available.

The most widely known proposal is the Transport Protocol proposed by IFIP and known as INWG 96.1 [15], which could serve as a basis for defining an international standard.

E. Protocols for the Session Layer

No standard exists and no proposal has been currently available, since in most networks, session functions were often considered as part of higher layer functions such as Virtual Terminal and File Transfer.

A standard Session Layer Protocol can easily be extracted from existing higher layer protocols.

F. Presentation Layer Protocol

So far, Virtual Terminal Protocols and part of Virtual File are considered the most urgent protocols to be developed in the Presentation Layer.

A number of VTP's are available (e.g., [16], [17]), many of them being very similar, and it should be easy to derive a Standard VTP from these proposals, also making use of the ISO standard for "Extended Control Characters for I/O Imaging Devices" [18]. These protocols are reviewed in another paper in this issue [19].

The situation is similar for File Transfer Protocols.

G. Management Protocols

Most of the work within ISO has been done so far on the architecture of management functions, and very little work has been done on management protocols themselves. Therefore, it is too early to give indications on the likely results of the ISO work in this area.

VIII. CONCLUSION

The development of OSI Standards is a very big challenge, the result of which will impact all future computer communication developments. If standards come too late or are inadequate, interconnection of heterogeneous systems will not be possible or will be very costly.

The work collectively achieved so far by SC16 members is very promising, and additional efforts should be expended to capitalize on these initial results and come up rapidly with the most urgently needed set of standards which will support initial usage of OSI (mainly terminals accessing services and file transfers). The next set of standards, including OSI management and access to distributed data, will have to follow very soon.

Common standards between ISO and CCITT are also essential to the success of standardization, since new services announced by PTT's and common carriers are very similar to data processing services offered as computer manufacturer products, and duplication of now compatible standards could simply cause the standardization effort to fail. In this regard, acceptance of the OSI Reference Model by CCITT Rapporteur's Group on Layered Architecture for Public Data Networks Services is most promising.

It is essential that all partners in this standardization process expend their best effort so it will be successful, and the benefits can be shared by all users, manufacturers of terminals and computers, and the PTT's/common carriers.

ACKNOWLEDGMENT

The OSI Architecture model briefly described in this paper results from the work of more than 100 experts from many countries and international organizations. Participation in this collective work was really a fascinating experience for the author who acknowledges the numerous contributions from SC16 members which have been merged in the final version of the OSI Architecture briefly presented here.

C&ase2:105-7cv-v00043398FGMHSCE DDooccuummeenntt190313517 FFiilleedd0061/2288/22000077 PPaaggee99ooff99

REFERENCES

[1] L. G. Roberts and B. D. Wessler, "Computer network development to achieve resource sharing," in *Proc. SJCC*, 1970, pp. 543–549.
[2] L. Pouzin, "Presentation and major design aspects of the CYCLADES computer network," in *Proc. 3rd ACM-IEEE Commun. Symp.*, Tampa, FL, Nov. 1973, pp. 80–87.
[3] J. H. McFayden, "Systems network architecture: An overview," *IBM Syst. J.*, vol. 15, no. 1, pp. 4–23, 1976.
[4] G. E. Conant and S. Wecker, "DNA, An Architecture for heterogeneous computer networks," in *Proc.. ICCC*, Toronto, Ont., Canada, Ai 1976, pp. 618–625.
[5] H. Zimmermann, "High level protocols standardization: Technical and political issues," in *Proc. ICCC*, Toronto, Ont., Canada, Aug. 1976, pp. 373–376.
[6] ISO/TC97/SC16, "Provisional model of open systems architecture," Doc. N34, Mar. 1978.
[7] ISO/TC97/SC16, "Reference model of open systems interconnection," Doc. N227, June 1979.
[8] H. Zimmermann and N. Naffah, "On open systems architecture," in *Proc. ICCC*, Kyoto, Japan, Sept. 1978, pp. 669–674.
[9] H. V. Bertine, "Physical level protocols," this issue pp. 433–444.
[10] H. C. Folts, "Procedures for circuit-switched service in synchronous public data networks," and "X.25 transaction-oriented features—Datagram and fast select," this issue, pp. 489–496.
[11] J. W. Conard, "Character oriented data link control protocols," this issue, pp. 445–454.
[12] D. E. Carlson, "Bit-oriented data link control procedures," this issue, pp. 455–467.
[13] ISO, "High level data link control-elements of procedure," IS 4335, 1977.
[14] CCITT, "X25," *Orange Book*, vol. VIII-2, 1977, pp. 70–108.
[15] IFIP-WG 6.1, "Proposal for an internetwork end-to-end transport protocol," INWG Note 96.1; also, doc. ISO/TC97 SC16/N24, 46 pp., Mar. 1978.
[16] IFIP-WG 6.1, "Proposal for a standard virtual terminal protocol," doc. ISO/TC97/SC16/N23, 56 pp., Feb. 1978.
[17] EURONET, "Data entry virtual terminal protocol for EURONET," VTP/D-Issue 4, doc. EEC/WGS/165.
[18] ISO, "Extended control characters for I/0 imaging devices," DP 6429.
[19] J. Day, "Terminal protocols," this issue, pp. 585–593.

★

Hubert Zimmermann received degrees in engineering from Ecole Polytechnique, Paris, France, in 1963, and from Ecole Nationale Superieure des Telecommunications, Paris, France, in 1966.

He is presently in charge of the computer communications group at IRIA, Rocquencourt, France. He was involved in development of command and control systems before joining IRIA in 1972 to start the CYCLADES project with L. Pouzin. Within CYCLADES, he was mainly responsible for design and implementation of host protocols.

Dr. Zimmermann is a member of IFIP WG 6.1 [International Network Working Group (INWG)]. He also chaired the Protocol Subgroup and co-authored several proposals for international protocols. He is an active participant in the development of standards for Open Systems Interconnection (OSI) within ISO, where he chairs the working group on OSI architecture.

REM 0086909

Exhibit 17

IEEE Std 100-1996

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

ISBN 1-55937-833-6

90000

9 781559 378338

REM 0086899

photovoltaic system-utility interface (terrestrial photovoltaic power systems) The interconnection between the power conditioning subsystem, the on-site ac loads, and the utility. *Synonym:* PV system-utility interface. *See also:* array control. (PV) 928-1986r

PhPDU *See:* physical protocol data unit.

PHR *See:* physical record.

PhsDU *See:* physical interface data unit.

PhSDU *See:* physical protocol service unit; physical service data unit.

PhS_User *See:* physical service user.

PHY Abbreviation for physical. *See also:* physical layer. (C/LM) 802.5-1989s

PHY layer *See:* physical layer.

PHY packet A packet either generated or received by the cable physical layer. These packets are always exactly 64 bits long where the last 32 bits are the bit complement of the first 32 bits. (C/MM) 1394-1995

physical (data management) Pertaining to the representation and storage of data on a data medium such as magnetic disk, or to characteristics of the data such as the length of data elements or records. *Contrast:* logical. (C) 610.5-1990

physical address (1) A unique identifier that selects a particular device from the set of all devices connected to a particular bus. (BA/C) 1275-1994

(2) The address of a data item in physical memory. *See also:* virtual address. (C) 610.10-1994

physical address space The set of possible physical addresses for a particular bus. (BA/C) 1275-1994

physical architecture An arrangement of physical elements that provides the design solution for a consumer product or life-cycle process intended to satisfy the requirements of the functional architecture and the requirements baseline. (C/SE) 1220-1994

physical characteristics The physical *design* attributes or distinguishing features that pertain to a measurable description of a product or process. (C/SE) 1220-1994

physical child segment In a hierarchical database, a child segment in a physical database. *See also:* logical child segment. (C) 610.5-1990

physical circuit (data transmission) A two-wire metallic circuit that is not arranged for phantom use. (PE) 599-1985w

physical coding sublayer (PCS) A sublayer used in 100BASE-T to couple the MII and the PMA. The PCS contains the functions to encode data bits into code-groups that can be transmitted over the physical medium. Two PCS structures are defined for 100BASE-T—one for 100BASE-X and one for 100BASE-T4. (C/LM) 802.3u-1995

physical concept Anything that has existence or being in the ideas of man pertaining to the physical world. Examples are magnetic fields, electric currents, electrons. (Std100) 270-1966w

physical configuration audit (software) An audit conducted to verify that a configuration item, as built, conforms to the technical documentation that defines it. *See also:* functional configuration audit. (C) 610.12-1990

physical connection The full-duplex physical layer association between directly connected nodes. In the case of the cable physical layer, this is a pair of physical links running in opposite directions. (C/MM) 1394-1995

physical damage (rotating machinery) This contributes to electrical insulation failure by opening leakage paths through the insulation. Included here are: physical shock, vibration, overspeed, short-circuit forces, erosion by foreign matter, damage by foreign objects, and thermal cycling. (PE) 432-1976s

physical database (A) (data management) A database as it is actually stored. **(B) (data management)** A database containing a collection of related segments or records that are physically stored together. *Note:* Segments within a physical database are known as physical segments. *Contrast:* logical database. (C) 610.5-1990

physical data model (data management) A data model that represents the implementation of the data contained in a data structure. *Contrast:* logical data model. (C) 610.5-1990

physical defect *See:* fault.

physical element A product, subsystem, assembly, component, subcomponent, subassembly, or part of the physical architecture defined by its designs, interfaces (internal and external), and requirements (functional, performance, constraints, and physical characteristics). (C/SE) 1220-1994

physical entity *See:* physical quantity.

physical format *See:* low-level format.

physical_ID The least-significant 6 bits of the node_ID. This number is unique on a particular bus and is chosen by the physical layer during initialization. (C/MM) 1394-1995

physical interface (1) The circuitry that interfaces the module, board(s), and node(s) to the bus signals. (C/MM) 1212-1991s

(2) The circuitry that interfaces a module's nodes to the input link, output link, and miscellaneous signals. (C/MM) 1596-1992, 1596.3-1996

physical interface data unit (PhsDU) An octet (8 data bits) that is communicated across the interface between a BCC or a DCC Physical layer and Data Link layer. (EMB) 1073.3.1-1994

physical layer (1) (Layer 1) The layer of the ISO Reference Model that provides the mechanical, electrical, functional, and procedural characteristics access to the transmission medium. (C/DIS) 1278.2-1995

(2) In this part of ISO/IEC 8802, the subdivision that provides the protocol to allow transfer of *slot octets, management information octets,* and *DQDB Layer* timing information over the *transmission link* between *DQDB Layer subsystems* at adjacent *nodes*. The Physical Layer provides the service to the *DQDB Layer*. (C/LM) 8802-6-1994

(3) The first layer of the seven-layer OSI model; responsible for transporting bits between adjacent systems. *Note:* This layer accepts a bit stream, called a frame, from the data link layer and places it on the media. It also performs the inverse operation of extracting a bit stream from the physical media and passes it to the data link layer. This layer describes mechanical and electrical characteristics of the connection, as well as the required interchange circuits. *See also:* application layer; client layer; data link layer; entity layer; logical link control sublayer; medium access control (MAC) sublayer; network layer; presentation layer; session layer; sublayer; transport layer. (C) 610.7-1995

(4) The layer, in a stack of three protocol layers defined for the Serial Bus, that translates the logical symbols used by the link layer into electrical signals on the different Serial Bus media. The physical layer guarantees that only one node at a time is sending data and defines the mechanical interfaces for the Serial Bus. There are different physical layers for the backplane and for the cable environment. See figure 34 for the relation of the physical layer to the Serial Bus protocol stack. (C/MM) 1394-1995

(5) The layer responsible for interfacing with the transmission medium. This includes conditioning signals received from the MAC for transmitting to the medium and processing signals received from the medium for sending to the MAC. (C/LM) 8802-5-1995

physical layer convergence procedure (PLCP) The part of the *Physical Layer* that supports the transfer of *slot octets, management information octets,* and *DQDB Layer* timing information in a manner that adapts the capabilities of the *transmission system* to the service expected by the DQDB Layer. (C/LM) 8802-6-1994

physical layer entity The portion of the Physical Layer between the MDI and MII consisting of the PCS, PMA, and, if present, PMD sublayers. The PHY contains the functions that transmit, receive, and manage the encoded signals that are im-

<u>Exhibit 18</u>

OIPE JC13
OCT 28 1997
PATENT & TRADEMARK OFFICE

#6M
Amdt B
11-3-97

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of: **Robert Scott**	)		
Serial No.: 08/780,762	)	Art Unit:	2614
Filed: January 8, 1997	)	Examiner:	J. Gluck
For: PRESETTING LINK LAYER PARAMETERS PER PHYSICAL LAYER STARTUP	)	*Docket:*	*061605-0590*

FIRST RESPONSE WITH AMENDMENTS

Assistant Commissioner for Patents
Box Amendments
Washington, DC 20231

Atlanta, GA

October 23, 1997

Sir:

In response to the nonfinal Office Action of September 12, 1997, (Paper No. 4), Applicant submits the following response with amendments and remarks.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to Paradyne Corporation's Fee Deposit Account No. 16-0255.

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope, with sufficient postage, addressed to: Assistant Commissioner for Patents, Box Amendments, Washington, D.C. 20231 on Oct. 23, 1997.

Signature: [signature]

IN THE SPECIFICATION

Page 2, line 1, delete "exists" and replace with --exist--.

Page 3, line 22, delete "a".

Page 6, line 21, delete "significance" and replace with --significant--.

Page 7, line 18, delete "obtain" and replace with --obtaining--.

Page 7, line 18, after "T1" and before "to" add --connection--.

Page 8, line 7, delete "modem" and replace with --modems--.

Page 9, line 22, delete "modem" and replace with --modems--.

Page 12, line 8, delete "cancellor" and replace with --cancellers--.

Page 12, line 19, delete "The" and replace with --This--.

Page 13, line 10, delete the phrase "with certain designed implications that".

Page 14, lines 9-12, delete the phrase "Alternatively, if the calling modem detects the ANS answer signal (2100 hz) in block 86, then it communicates with the answer modem using the ETC 1™ communication protocol and the V.32bis training in block 87. If the ANSam answer signal is detected at block 88, then it communicates in V.34 mode as indicated in block 89."

Page 14, line 21, delete the phrase "not. As" and replace with --not, as--.

Page 14, line 22, delete the phrase "install time." and replace with --installation.--.

Page 14, line 30, delete "assume" and replace with --assumes--.

Page 15, line 20, delete "establish" and replace with --established--.

Page 16, line 7, delete "INFO," and replace with --INFO sequences,--.

Page 18, line 11, delete the first occurrence of "the".

Page 19, lines 6-7, delete the phrase "used other than those disclosed herein." and replace with --used.--.

Page 23, line 4, delete the first occurrence of "a" and replace with --an--.

IN THE CLAIMS

Amend the following pending claims by deleting that language which is enclosed within brackets ("[ ]") and by inserting that language which is underlined ("___").

1. (Once Amended) A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a pluralilty of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:

B1

establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

establishing <u>said</u> link layer connection based upon said negotiated physical layer modulation.

IN THE DRAWINGS

The drawings are sought to be amended to comply with requirements made in the outstanding Office Action. In accordance with 37 C.F.R. §1.123, proposed changes to the drawings are indicated in red ink on separate pages accompanying this amendment.

25

REMARKS

This is in full and timely response to the nonfinal Office Action of September 12, 1997. Reexamination, reconsideration, and allowance of the application and all presently pending claims are respectfully requested.

Upon entry of this Amendment, claims 1-10 remain pending in this application. Furthermore, amendments to Fig. 6 and Fig. 7 have been submitted herewith. Fig. 6 has been amended to correct for a minor clerical error, and Fig. 7 has been amended to comply with a requirement for correction by the Examiner. It is believed that the foregoing amendments and additions add no new matter to the present application.

Objection to Drawings

Fig. 7 is objected to in the Office Action as containing the term "WDG" which is not specified in the specification. An amendment to Fig. 7 has been submitted herewith, and it is believed that Fig. 7, as amended, complies with the Examiner's requirement for correction.

Claim Rejections

A proper rejection of a claim under 35 U.S.C. §102 requires that a single prior art reference disclose each element of the claim. See, *e.g., W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983). Furthermore, in order for a claim to be properly rejected under 35 U.S.C. §103, the combined teachings

of the references must suggest all features of the claimed invention to one of ordinary skill in the art. See, *e.g., In Re Dow Chemical*, 5 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1988), and *In re Keller*, 208 U.S.P.Q.2d 871, 881 (C.C.P.A. 1981). However, a reference teaches away from the claimed invention and should not be used under 35 U.S.C. §103 if "a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *In re Gurley*, 2 F.3d 551, 31 U.S.P.Q.2d 1130, 1131 (Fed Cir. 1994).

Rejections under *Abbie*

Claim 1

Claim 1 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Claim 1 reads as follows:

> 1. A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:
>
> **establishing a physical layer connection** between said calling and said answering modems, **wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations;** and
>
> establishing said link layer connection based upon said negotiated physical layer modulation. (Emphasis added)

Applicant respectfully asserts that *Abbie* does not teach the features of pending claim 1. In particular, *Abbie* fails to suggest or teach at least the concept of establishing a

physical layer that "is based on a negotiated physical layer modulation" chosen from various physical layer modulations as defined by the highlighted portion of pending claim 1 hereinabove.

In establishing a physical layer in one embodiment of the present invention, a calling modem transmits a calling signal to an answer modem. See Page 9, line 17, through Page 10, line 2. The answer modem uses the calling signal to recognize that the calling modem is capable of fast connection, and the answer modem notifies the calling modem whether the answer modem is capable of fast connection. See Page 10, line 21, through Page 11, line 14. Moreover, physical layer modulation with fast connection protocol is chosen only if both modems are capable of fast connection. If either one of the two modems is incapable of fast connection, a different type of physical layer modulation is chosen. See Page 11, line 23, through Page 12, line 27. By choosing a physical layer modulation based on the capabilities of the two modems as determined at run time, the two modems "negotiate" an appropriate physical layer modulation scheme.

Abbie, on the other hand, ***commands*** the answer modem to perform a fast connect. Col. 4, lines 18-21, and Col. 4, lines 31-34. There is no negotiation wherein the calling modem accommodates the incapability of the answer modem to carry out a fast connect command. The answer modem simply responds to the calling modem, and there is nothing in *Abbie* to suggest a negotiating system or method. Therefore, *Abbie* fails to teach the feature of having a physical layer connection based on "a negotiated physical layer modulation."

Furthermore, since the answer modem in *Abbie* must respond to a fast connect command, *Abbie* teaches that each computer should have a modem with "a fast modem connect protocol." Col. 4, lines 14-17. This teaches away from the present invention which allows modems with different connection speeds to establish a mutually acceptable protocol. Applicant respectfully submits that one of ordinary skill in the art, upon reading *Abbie*, would be discouraged from using *Abbie* to implement a negotiating system or method since *Abbie* specifically teaches using modems having fast connect capabilities. Accordingly, under the principles of *In re Gurley*, *Abbie* should not be used to render the present invention obvious.

Because *Abbie* teaches away from the present invention and fails to disclose or suggest a physical layer connection "based on a negotiated physical layer modulation" chosen from various physical layer modulations, *Abbie* fails to anticipate the present invention under 35 U.S.C. §102 or, in the alternative, to render the present invention obvious under 35 U.S.C. §103.

<u>Claims 2-5</u>

Claims 2-5 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Applicant submits that the pending dependent claims 2-5 contain all features of their respective independent claim 1. Since claim 1 should be allowed, as argued hereinabove, pending dependent claims 2-5 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite

patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 1.

Claim 6

Claim 6 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. However, similar to claim 1, claim 6 contains a "means for establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from" various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 6, as presently set forth, is allowable. Furthermore, pending claim 6 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 6 allowable.

Claims 7-9

Claims 7-9 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Applicant submits that the pending dependent claims 7-9 contain all features of their respective independent claim 6. Since claim 6 should be allowed, as argued hereinabove, pending dependent claims 7-9 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 6.

Claim 10

Claim 10 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. However, similar to claim 1, claim 10 contains the feature of "establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from" various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 10, as presently set forth, is allowable. Furthermore, pending claim 10 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 10 allowable.

Rejections under *McGlynn*

Claim 1

Claim 1 also stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, Applicant respectfully asserts that *McGlynn* also fails to teach at least the feature in pending claim 1 of "establishing a physical layer connection...based on a negotiated physical layer modulation chosen from said first and second physical layer modulations."

There are two phases in establishing a physical layer connection. First, there is an automatic mode synchronization phase, and then there is a modem training and startup phase. See Page 9, lines 4-22, and Fig. 2 of the present invention. Physical layer modulation is determined during the first phase, the automatic mode

synchronization phase. See Page 15, lines 18-23, and Figs. 4, 5, 6, and 7. Therefore, the training and startup sequence is performed subsequent to the negotiation of a physical layer modulation scheme.

McGlynn negotiates for a listing of common features "after completing conventional or standard handshaking sequences." See Abstract and Col. 8, lines 2-5. Applicant submits that the "conventional or standard handshaking sequences" referred to by *McGlynn* are the handshaking sequences performed in the modem training and startup sequence disclosed in Fig. 2 of the present invention. This is supported by comparing the automatic mode synchronization phase described by the present invention (See Fig. 2, Fig. 3 and Page 9, line 23, through Page 11, line 14) to the teachings of *McGlynn* referring to the timing of the negotiation period. Col. 8, lines 21-41. Since the negotiations in *McGlynn* occur subsequent to the "conventional or standard handshaking sequences" of the training and start up sequence, then the negotiations in *McGlynn* necessarily occur subsequent to the establishment of physical layer modulation which, as indicated hereinabove, occurs prior to the training and start up sequence.

Accordingly, the negotiations in *McGlynn*, unlike the negotiations in pending claim 1, fail to include the negotiation of physical layer modulation. Instead, the negotiations taught in *McGlynn* only determine which features can be subsequently used by the two modems once a physical layer modulation has already been established. See Col. 3, lines 51-56. As a result, *McGlynn* fails to teach or suggest

the negotiation of physical layer modulation as described in pending claim 1, and *McGlynn* should not be used to reject claim 1.

For at least the foregoing reasons, claim 1, as presently set forth, is allowable.

Claims 2-5

Claims 2-5 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. Applicant submits that the pending dependent claims 2-5 contain all features of their respective independent claim 1. Since claim 1 should be allowed, as argued hereinabove, pending dependent claims 2-5 should be allowed as a matter of law for at least this reason. *In re Fine,* 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 1.

Claim 6

Claim 6 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, similar to claim 1, claim 6 contains a "means for establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from" various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 6, as presently set forth,

is allowable. Furthermore, pending claim 6 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 6 allowable.

Claims 7-9

Claims 7-9 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. Applicant submits that the pending dependent claims 7-9 contain all features of their respective independent claim 6. Since claim 6 should be allowed, as argued hereinabove, pending dependent claims 7-9 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 6.

Claim 10

Claim 10 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, similar to claim 1, claim 10 contains the feature of "establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from" various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 10, as presently set forth, is allowable. Furthermore, pending claim 10 recites other patentably distinct

features and/or combinations of features not discussed herein that make claim 10 allowable.

CONCLUSION

Applicant respectfully requests that all outstanding objections and rejections be withdrawn and that this application and all presently pending claims be allowed to issue. If the Examiner has any comments regarding Applicant's response, the Examiner is encouraged to telephone Applicant's undersigned counsel.

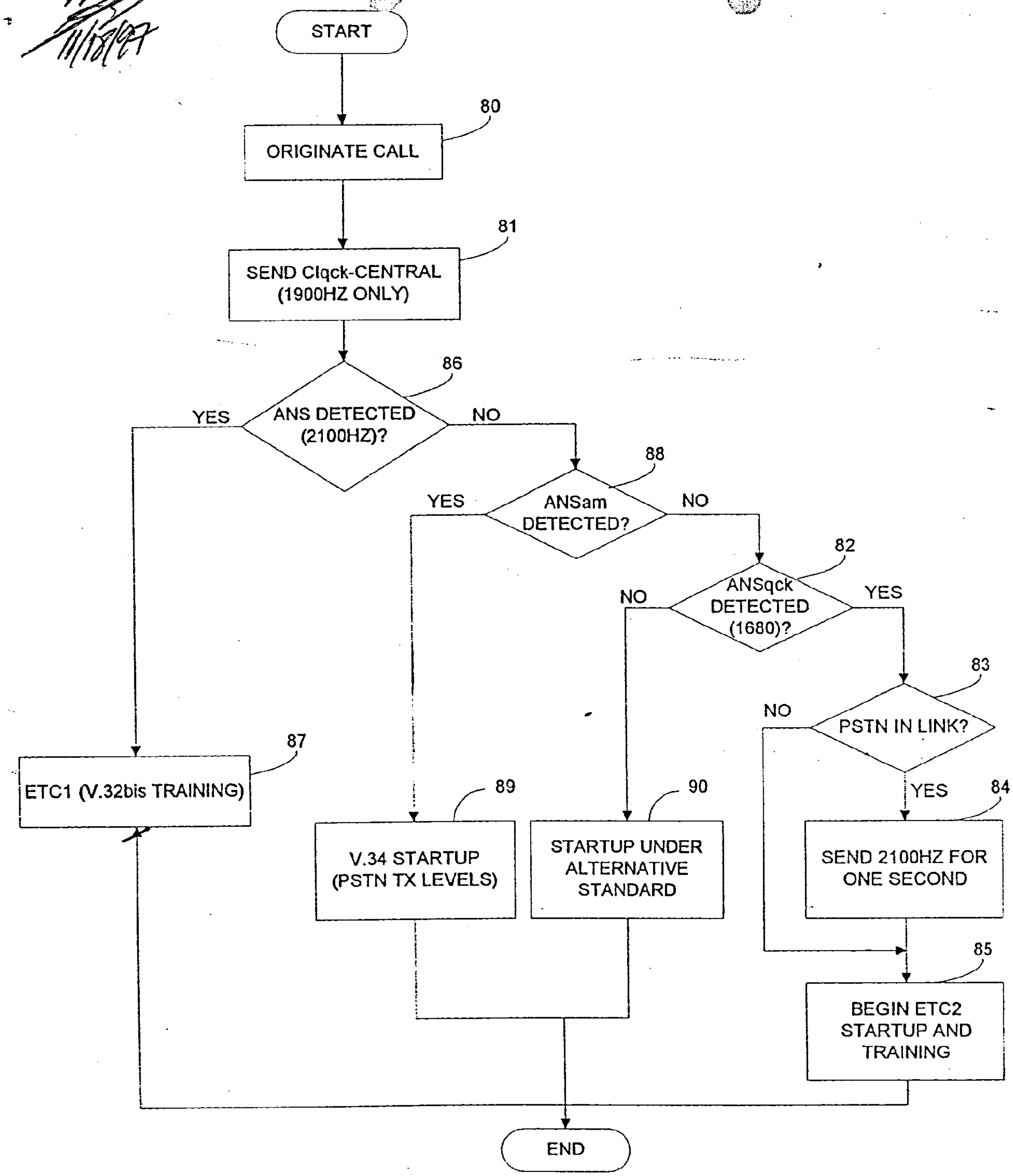
Respectfully submitted by,

Scott A. Horstemeyer
Registration No. 34,183

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.
100 Galleria Parkway, N.E.
Suite 1500
Atlanta, Georgia 30339
(770) 933-9500

Docket No.: 061605-0590

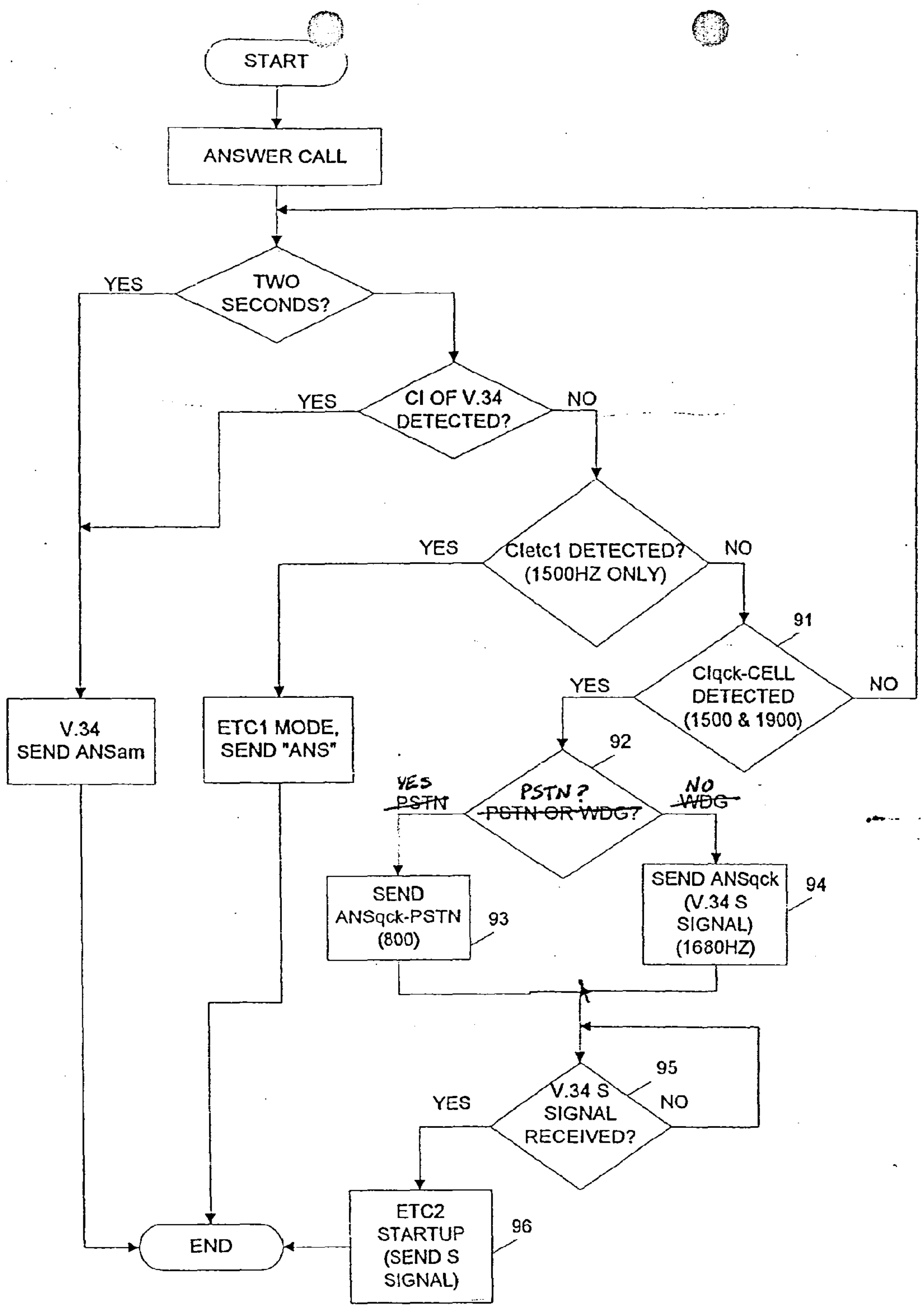
Approved
11/18/97



Calling Modem -- Central Site

FIG. 6

OIPE JC13
OCT 28 1997
PATENT & TRADEMARK OFFICE



Answer Modem -- Central Site

FIG. 7

O I P E JC13
OCT 2 8 1997
PATENT & TRADEMARK OFFICE

GP2614

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Robert Scott

Serial No.: 08/780,762

Filed: January 8, 1997

For: PRESETTING LINK LAYER PARAMETERS PER PHYSICAL LAYER START-UP

Docket No.: *061605-0590*

Examiner: J. Gluck

Art Unit: 2614

OIPE OCT 28 1997 PATENT & TRADEMARK OFFICE

RECEIVED OCT 31 1997 GROUP 2600

TRANSMITTAL LETTER FOR AMENDMENT

The Commissioner of Patents and Trademarks
Box Amendments
Washington, D.C. 20231

Atlanta, GA
October 23, 1997

Sir:

Transmitted herewith is/are the following in the above-identified application:

[X] Response/Amendment
[ ] Fee as calculated below
[X] No Additional Fee Required
[X] Corrected Drawings

[X] Return Postcard
[ ] Supplemental Declaration
[ ] Check in the Amount of $_____
[ ] Terminal Disclaimer

CLAIMS AS AMENDED BY A LARGE ENTITY						
Claims Remaining After Amendment		Highest Number Previously Paid For		Present Extra	Rate	Additional Fees
Total Claims	10	Minus	20	0	x $22.00	$ -0-
Independent Claims	3	Minus	3	0	x $82.00	$ -0-
[ ] First Presentation of A Multiple Dependent Claim					+ $270	$ -0-
EXTENSION FEE	1st Month $110 [ ]	2nd Month $400 [ ]	3rd Month $950 [ ]	4th Month $1,510 [ ]		$ -0-
			TOTAL ADDITIONAL FEE FOR THIS AMENDMENT			$ -0-

[ ] The Commissioner is authorized to charge Paradyne Corporation's Deposit Account No. 16-0255 in the amount of $______ to cover the above listed additional fees.

[X] In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit **Paradyne Corporation's Deposit Account No. 16-0255** as required to correct the error. A duplicate copy of this transmittal is enclosed.

THOMAS, KAYDEN, HORSTEMEYER
& RISLEY, L.L.P.
100 Galleria Parkway
Suite 1500
Atlanta, Georgia 30339
(770) 933-9500

Respectfully submitted,

Scott Horstemeyer

Scott A. Horstemeyer
Registration Number 34,183

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope, with sufficient postage, addressed to: Assistant Commissioner for Patents, Box Amendments, Washington, D.C. 20231 on

Oct. 23, 1997

Signature: [signature]

<u>Exhibit 19</u>

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

ISBN 1-55937-833-6

90000

9 781559 378338

(11) The transmission path between any two interfaces of generic cabling. (C/LM) 802.3u-1995
(12) *See also:* directory entry. (C/PA) 1003.1b-1993s, 1003.2-1992s, 1003.5-1992, 1003.5b-1995
(13) *See also:* link, connector. (PE/T&D) 524-1992

linkage (1) (programming) Coding that connects two separately coded routines. (C) [85]
(2) (software) *See also:* link. (C) 610.12-1990

linkage editor (software) A computer program that creates a single load module from two or more independently translated object modules or load modules by resolving cross-references among the modules and, possibly, by relocating elements. May be part of a loader. *Synonym:* linker. *See also:* linking loader. (C) 610.12-1990

linkage product A device that provides an interface between network segments such as gateways or bridges. (C) 610.7-1995

linkage voltage test, direct-current test (rotating machinery) A series of current measurements, made at increasing direct voltages, applied at successive intervals, and maintained for designated periods of time. *Note:* This may be a controlled overvoltage test. *See also:* asynchronous machine. (PE) [9]

link-attached terminal A terminal that is connected to the computer by telecommunication lines or by a data link. *Contrast:* channel-attached terminal. (C) 610.10-1994

link-break cutout A load-break fuse cutout that is operated by breaking the fuse link to interrupt the load current. (PE/SWG) C37.100-1992, C37.40-1993

link cable The physical medium connecting two link interfaces, comprising of two or more electrical or optical cables. (BA/C) 1355-1995

Link Code Word The 16 bits of data encoded into a Fast Link Pulse Burst. (C/LM) 802.3u-1995

link communication A physical means of connecting one location to another for the purpose of transmitting and receiving information. (C) 610.7-1995

link character (L_char) Control characters which are used on a link in order to ensure flow control and the proper functioning of the link. *See also:* normal character. (BA/C) 1355-1995

link, connector A rigid link designed to connect pulling lines and conductors together in series. It will not spin and relieve torsional forces. *Synonyms:* bullet; connector; link; slug. (PE/T&D) 524-1992

link count The number of directory entries that refer to a particular file. (C/PA) 1003.5-1992, 1003.5b-1995, 9945-1-1996, 9945-2-1993

linked linear list A linear list in which each item contains a pointer to the next item in the list, making it unnecessary for the items to be physically sequential. *Note:* the items are still logically adjacent. *Synonym:* linear linked list. (C) 610.5-1990

linked list (1) A list in which each item contains a pointer to the next or preceding item in the list, making it unnecessary for the items to be physically sequential. *Note:* Unless the list is circular, the last item in the list contains a null link field. *Synonyms:* chain; singly linked list. *See also:* chained list; circularly-linked list; linked linear list. (C) 610.5-1990
(2) (software) *See also:* chained list. (C/SE) 729-1983s

Linked List A software data structure composed of individually allocated memory objects, in which each item points to the next. It is used as a FIFO queue in this document. (C/MM) 1212.1-1993

linker *See:* linkage editor.

link error counter (LEC) A counter maintained by a network station to track all data link errors. The maximum permissible value is a system parameter. (EMB) 1073.3.1-1994

link field (A) A field in each item of a linked list, containing a pointer to the next or preceding item in the list. *Synonym:* chain field. **(B)** In a tree, that portion of each node that contains a pointer to other nodes in the tree. (C) 610.5-1990

linking loader A computer program that reads one or more object modules into main memory in preparation for execution, creates a single load module by resolving cross-references among the separate modules, and, in some cases, adjusts the addresses to reflect the storage locations into which the code has been loaded. *See also:* absolute loader; linkage editor; relocating loader. (C) 610.12-1990

link input A connection point for receiving signals. *See also:* link interface. (BA/C) 1355-1995

link interface (port) A connection point comprising a link input and a link output and implementing one of the relevant conformance subsets defined in IEEE Std 1355-1995. *See also:* link. (BA/C) 1355-1995

link is clear A condition in which there is no incoming energy on the link. *See also:* clear. (C/LM) 802.12-1995

link layer (LINK) (1) (Layer 2) The layer of the ISO Reference Model that provides the functional and procedural means to transfer data between stations, and to detect and correct errors that can occur in the Physical layer. (C/DIS) 1278.2-1995
(2) The layer, in a stack of three protocol layers defined for the Serial Bus, that provides the service to the transaction layer of one-way data transfer with confirmation of reception. The link layer also provides addressing, data checking, and data framing. The link layer also provides an isochronous data transfer service directly to the application. See figure 34 for the relation of the link layer to the Serial Bus protocol stack. (C/MM) 1394-1995

link output A connection point for transmitting signals. *See also:* link interface. (BA/C) 1355-1995

link pair A pair of links going in opposite directions between two stations. (C/LM) 802.5c-1991

link partner The device at the opposite end of a link segment from the local station. The link partner device may be either a DTE or a repeater. (C/LM) 802.3u-1995

link protocol In OSI, a protocol that ensures that the transmission of bits received are the same as the bits sent. (C) 610.7-1995

link pulse Communication mechanism used in 10BASE-T and 100BASE-T networks to indicate link status and (in Auto-Negotiation-equipped devices) to communicate information about abilities and negotiate communication methods. 10BASE-T uses Normal Link Pulses (NLPs), which indicate link status only. 10BASE-T and 100BASE-T nodes equipped with Auto-Negotiation exchange information using a Fast Link Pulse (FLP) mechanism that is compatible with NLP. (C/LM) 802.3u-1995

link segment (1) The physical interconnection between two repeaters or between a repeater and an end node. A link segment includes the link medium (twisted pairs or optical fibres) and its two attached Medium Dependent Interface (MDI) connectors. (C/LM) 802.12-1995
(2) The point-to-point full-duplex medium connection between two and only two MDIs. (C/LM) 802.3u-1995

Link Segment Delay Value (LSDV) A number associated with a given segment that represents the delay on that segment used to assess path delays for 100Mb/s CSMA/CD networks. LSDV is similar to SDV; however, LSDV values do not include the delays associated with attached end stations and/or repeaters. (C/LM) 802.3u-1995

link, swivel *See:* swivel link.

lin-log receiver A receiver having a linear amplitude response for small-amplitude signals and a logarithmic response for large-amplitude signals. (AE) 686-1990w

lip *See:* hook, conductor lifting.

lip microphone A microphone adapted for use in contact with the lip. *See also:* microphone. (EEC/PE) [119]

Exhibit 20

International Conference on
Information, Communications and Signal Processing
ICICS '97
Singapore, 9-12 September 1997

1B2.1

Performance Analysis of CDMA_ALOHA/FEC Scheme in the Centralized Packet Radio Networks

In-Taek Lim

Dept. of Computer Science,
Dong-Pusan College,
640,Bangsong-Dong,Haeundae-Gu,
Pusan, 612-715, KOREA,

Jeong-Seok Heo

Dept. of Computer Engineering,
University of Ulsan
San 29, Mugeo-Dong, Nam-Gu,
Ulsan, 680-749,KOREA

Abstract

In this paper, we analyze the performance of a CDMA_ALOHA scheme by considering the packet collision probability as well as the bit error probability. And we propose a new CDMA_ALOHA/FEC scheme which uses a block FEC code in the data link layer for correcting bit errors of the received packets. By analyzing the proposed scheme, we show that the system throughput closely relates to the bit error rates. The results also show that the system throughput can be significantly improved by using the FEC coding, approaching to the value which is competitive with the error-free channel.

1. Introduction

In recent years, there has been increased demands for mobile/personal communications services through wireless data networks. However, due to limited radio resources, only a finite number of mobile users can access the radio communication channels. Multiple access control protocols must be implemented to efficiently utilize the radio resources among all the users, and there has been increased interest and development in the multiple access protocols[1,2]. In particular, CDMA techniques are increasingly being used or considered for commercial applications, and are being developed as potential candidates in digital cellular mobile radio[2,3]

The MAC (Medium Access Control) protocol has a primary effect in the throughput and the delay performance of the wireless networks. Among a lot of MAC protocols, ALOHA schemes, having a distinguished advantage of simplicity, experience the rapid decreases of performance under heavy traffic conditions due to collisions[10]. On the other hand, many researchers have been already devoted for applying either slotted or unslotted ALOHA protocols to the CDMA systems. And they have been shown that CDMA_ALOHA techniques have an improved performance[5,7,8].

The bit error probability due to multiple access interference has a significant influence in the QoS and the system performance[3,4]. In this paper, we analyze the CDMA_ALOHA scheme by considering the packet collision probabilities of the MAC layer as well as the BER of the physical layer. And we propose a new CDMA_ALOHA/FEC scheme which uses a block FEC code in the data link control layer for improving the system performances. The numerical results show that the system throughput is significantly improved by using a block FEC code, approaching to value which is competitive with the error-free channels.

This paper is organized as follows. Section 2 describes the system model and proposes CDMA_ALOHA/FEC scheme. In Section 3, we analyze the system performance of the proposed scheme. Section 4 discusses the numerical results and conclusions are given in Section 5.

2. System Descriptions

As depicted in figure 1, it is assumed that the system

0-7803-3676-3/97/$10.00 © 1997 IEEE

REM 0087187

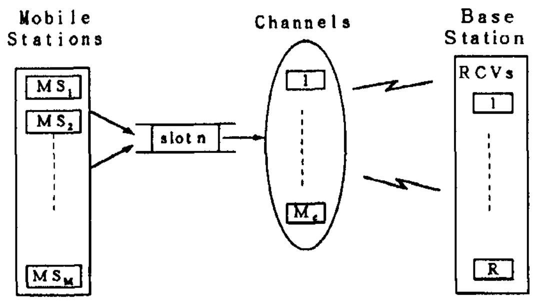


Figure 1. Wireless communication systems

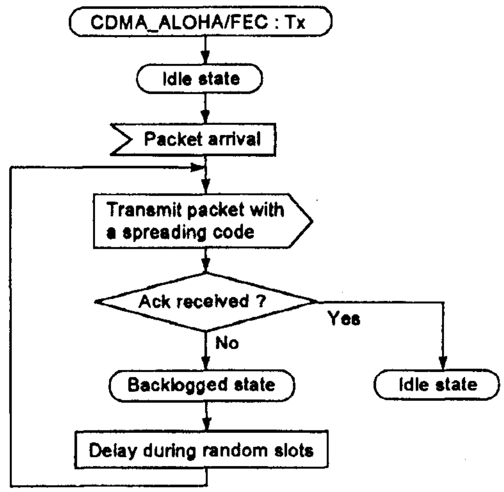
consists of a base station and M mobile stations. There are R receivers in the base station. For simplicity, we only focus on a single-cell system. Multiple channels are provided by M_c spreading codes which are orthogonal to each other. All the mobile users share the M_c spreading codes.

Basically, a CDMA_ALOHA/FEC scheme operates in a slotted ALOHA mode in the MAC layer and corrects bit errors by using a FEC code in the DLC layer. When a user wishes to transmit a packet, he randomly chooses one of the spreading codes $\{c_i, i=1, ..., M_c\}$, spreads and transmits in the next slot.

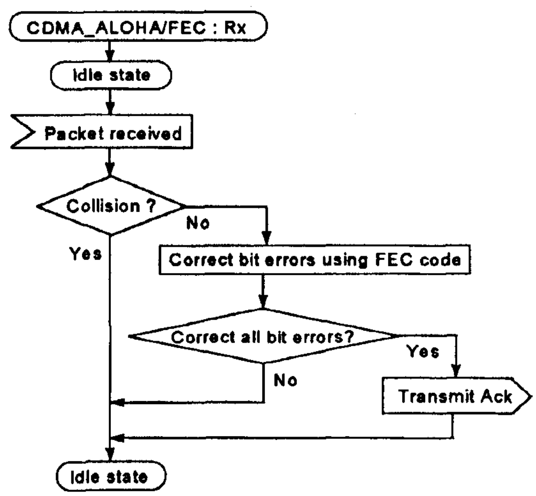
In this scheme, users suffer failures from transmission of a packet in the following reasons :

i) packet collision occurs, that is, at least two users select one particular spreading code,
ii) the received packet has errors that cannot be corrected with the FEC code, and
iii) all receivers in the base station are busy.

Users which fail to transmit enter into the backlogged state and retransmit its packet after a random delay. The detailed descriptions of the CDMA_ALOHA/FEC scheme are shown in figure 2.



(a) Mobile station's operation



(b) Base station's operation

Figure 2. Operations of CDMA_ALOHA/FEC

3. Performance Analysis

In this section, we analyze the system throughput of CDMA_ALOHA/FEC scheme using a markov model. It is assumed that the user will generate a new packet in the following slot with the probability λ. If a user fails to transmit its packet due to the reasons described in the above section, we assume that it enters into a backlogged state and retransmits its packet in the next slot with the probability P_r. If we let the system state $x(t)$ be the number of backlogged users at the beginning of slot t, it can be easily shown that $\{x(t)\}$ is a finite state markov chain. The state transition probability P_{jk}, which is derived from probabilities that n_b packets from the backlogged state retransmit and n_i users (out of M-j) generate a new packet and s packets (out of n_b+n_i) are successfully transmitted, is given by

$$P_{jk} = \sum_{n_b=0}^{j} \sum_{n_i=0}^{M-j} \left\{ \begin{matrix} B(j, n_b, P_r) \times B(M-j, n_i, \lambda) \times \\ S_s|n_b+n_i, M_c, R \end{matrix} \right\} \qquad (1)$$

where $s=j+n_i-k$, $0 \le s \le \mathrm{Min}\{M_c, R, n_b+n_i\}$, and

$$B(n,i,p)=\binom{n}{i}p^i(1-p)^{n-i}.$$

The term $S_{s|n_b+n_i,M_c,R}$ is the conditional probability that s packets (out of n_b+n_i) are successfully transmitted with M_c channels and R receivers available.

By conditioning on the number of packets simultaneously transmitted over the arbitrary first channel and using the total probability, we have

$$S_{s|n,M_c,R}=\sum_{i=0}^{n} B\left(n,i,\frac{1}{M_c}\right)\times P(s|n,i,M_c,R) \qquad (2)$$

where i is the number of packets transmitted over the first channel, and $B\left(n,i,\frac{1}{M_c}\right)$ is the probability that i packets (out of n) are transmitted over the first channel. The term $P(s|n,i,M_c,R)$ is the probability that i packets (out of n) select the first channel, and then s packets (out of i) succeed to transmit with the M_c channels and R receivers. The term $P(s|n,i,M_c,R)$ can be recursively derived by

$$P(s|n,i,M_c,R) = \begin{cases} S_{s|n,M_c-1,R} & \text{, for } i=0 \\ P_s(n)S_{s-1|n-1,M_c-1,R-1} + \\ (1-P_s(n))S_{s|n-1,M_c-1,R-1} & \text{, for } i=1 \\ P_s(n)P_c(i)S_{s-1|n-i,M_c-1,R-1} + \\ \{1-P_s(n)P_c(i)\}S_{s|n-i,M_c-1,R-1} & \text{, for } 2\le i\le n \end{cases} \qquad (3)$$

where $P_s(n)$ is the probability that all the bit errors in a received packet are corrected by using the FEC codes, and $P_c(i)$ is the probability that one out of i simultaneous packets is successfully captured by the receiver.

In (3), the term for i=0 is the probability that s packets must be successfully transmitted over the remaining channels because any packet does not select the first channel. The second term, for i=1, is the probability that s-1 packets (out of n-1) are successfully transmitted over the remaining channels in the case of having no packet errors. The third term is the probability that s-1 packets (out of n-i) are successfully transmitted over the remaining M_c-1 channels in the case of not only being captured by the receiver but also having no packet error.

The initial conditions for $S_{s|n,M_c,R}$ are given by

$$\begin{aligned} &\text{for } M_c \ge 0 \text{ and } R \ge 0,\ S_{0|0,M_c,R}=1,\ S_{1|0,M_c,R}=0 \\ &\text{for } n \ge 0 \text{ and } R \ge 0,\ S_{0|n,0,R}=1,\ S_{1|n,0,R}=0 \\ &\text{for } M_c \ge 1 \text{ and } R \ge 1,\ S_{0|1,M_c,R}=1-P_s(1), \\ &\qquad S_{1|1,M_c,R}=P_s(1) \\ &\text{for } n \ge 2 \text{ and } R \ge 1,\ S_{1|n,1,R}=P_s(n)\cdot P_c(n), \\ &\qquad S_{0|n,1,R}=1-P_s(n)\cdot P_c(n) \\ &\text{for } s > Min\{n,M_c,R\},\ S_{s|n,M_c,R}=0 \end{aligned} \qquad (4)$$

The probability $P_c(i)$ is given by

$$P_c(i)=\begin{cases}1 & \text{, for } i=1 \\ Q^i & \text{, for } i\ge 2 \\ 0 & \text{, otherwise}\end{cases} \qquad (5)$$

where i is the number of packets to be transmitted simultaneously over the same channel, and Q is the capture ratio[6].

By using the BER model in [4], we have the packet success probability $P_s(n)$ as

$$P_s(n)=\sum_{i=0}^{t}\binom{L}{i}P_e^i(n)(1-P_e(n))^{L-i} \qquad (6)$$

where L is the packet length, t is the maximum number of bits to be corrected, and $P_e(n)$ is the bit error probability in the environment of n multiple access interference as presented in [4].

$$P_e(n)=Q\left(\left[\frac{n-1}{3N}+\frac{N_0}{2E_b}\right]^{-\frac{1}{2}}\right) \qquad (7)$$

where, $Q(x)=\frac{1}{\sqrt{2\pi}}\int_x^{\infty}e^{-u^2/2}du$, and N is the processing gains. The FEC coding rate r is defined as $r=k/L$ where L is the packet length and k is the number of information bits.

Once the probability P_{jk} is obtained, we can derive the probability π_i [9] that the system is in state i, and the system throughput S that is the average number of new packets generated during one slot time. The system throughput is given by

$$S=\lambda\left(M-\sum_{i=0}^{M}i\pi_i\right) \qquad (8)$$

where $\pi_i=\sum_{j=0}^{M}\pi_j P_{ji}$, and $\sum_{i=0}^{M}\pi_i=1$

4. Numerical Results

In this section, we present some numerical results for the system throughput of the proposed scheme. At first, we illustrate how the performance of CDMA_ALOHA/ FEC scheme will be will affected by the BER due to the multiple access interference. In this analysis, we assume that M_c=3, R=3, and P_r=0.1. Figure 3 shows the throughput comparison between the error free ideal channel environment (a) and the erroneous channel one without the FEC coding (b). For simplicity, the capture capability is not considered in this figure (i.e. Q=0.0). Since the multiple access interference will increase along with the increase of the offered traffic load, the BER in the received packets will also increase, and inversely the packet success probability $P_s(n)$ will decrease. So the erroneous channels result in lower system throughput than the ideal channel conditions. By comparing figure 3(b) with figure 4 (FEC coding rate r=1.0), we manifest that the capture capabilities of the CDMA system improve the system throughput.

Figure 4 and 5 show the performance improvement through the FEC coding in the DLC layer. We assume that M=20, L=100 bits, M_c=3, R=3, Q=0.9. And for the $P_e(n)$ in the physical layer, E_b/N_0=6dB, and the processing gain N=16dB is assumed. When the FEC coding rate r decreases to 0.9, the system throughput increases about 40 percent as compared with r=1.0. And when r=0.8, the increase in the system throughput approaches to about 48 percent. As illustrated in the figure 4, if we enlarge the FEC code length for correcting more bit errors, the overall system throughput might be increased. But the user throughput, which is the throughput of the user data, is decreased as shown in figure 5 due to the packet overhead by the FEC codes.

In figure 6, we show how the FEC coding influences the system performance under the two different kind of processing gains (N=16dB, N=10dB). In general, the BER of the CDMA systems with the low processing gain increases more than the higher one. So, it results in the degradation of the system throughput. When N=16dB and r=0.8, the system performance is improved about 48 percent as compared with the no FEC coding. But in the case of N=10dB, there is about 110 percent increases in the throughput. So, from figure 6, we notice that the FEC coding in the data link control layer might be necessary for improving the system throughput, especially in the lower processing gain systems.

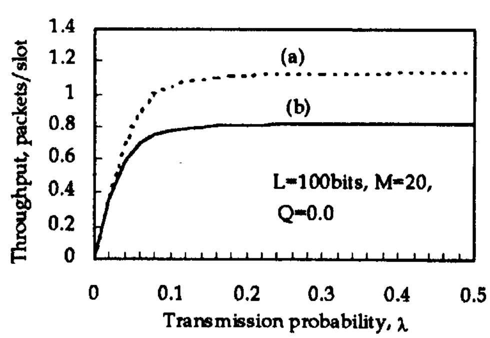


Figure 3. Through comparison between the error-free channel and the erroneous channel : (a) error free channel, (b) erroneous channel (E_b/N_0=6dB, N=20dB, r=1.0)

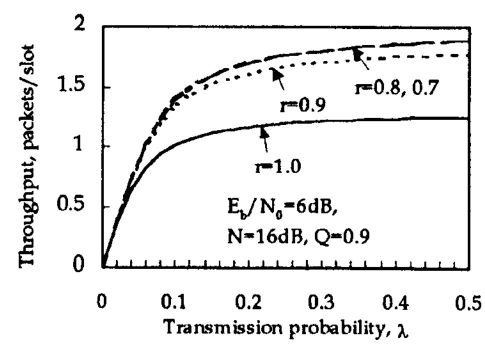


Figure 4. System throughput according to the FEC coding rates

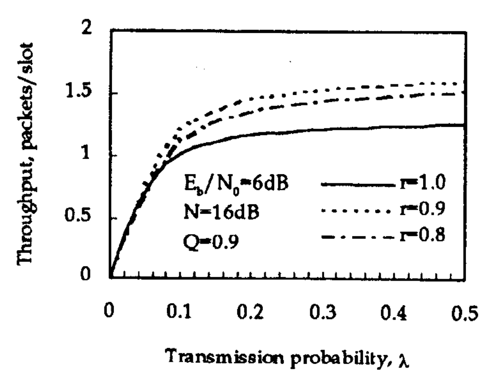


Figure 5. User Throughput

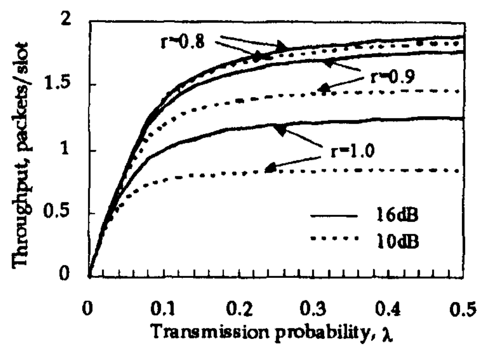


Figure 6. System throughput according to the processing gain

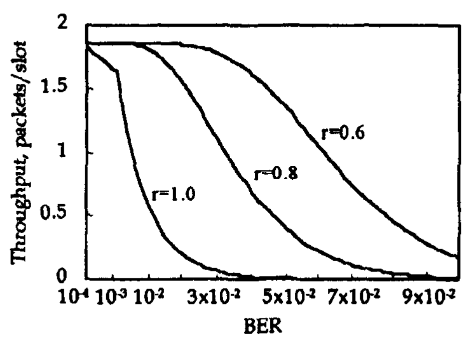


Figure 7. System throughput vs. BER (λ=0.394, Q=0.9)

The maximum achievable throughput and the optimum FEC coding rates in the various BER condition are depicted in figure 7. The retransmission scheme may be sufficient to achieve the maximum throughput under the bit error conditions of lower than 10^{-4}. But as expected, this figure notices that the FEC scheme at the DLC layer is necessary to improve the throughput as the BER increases.

5. Conclusions

We have proposed and analyzed a CDMA_ALOHA/FEC scheme to address the medium access control and the data link control for the centralized packet radio networks. In this scheme, a slotted ALOHA protocol is used as the medium access control, and the multiple channels are provided by the spreading codes. For the purpose of further reducing the packet error rates, we adapted the FEC scheme in the data link control layer.

It is observed that the BER by the multiple access interference affects the system performance. We also investigated that the FEC scheme at the data link control layer improves the throughput performance greatly.

References

[1] R.L.Pickholtz, et al., "Theory of Spread-Spectrum Communications - A Tutorial," IEEE Trans. on Commun., Vol. COM-30, No.5, pp.855-884, May 1982.

[2] Peter Jung, et al., "Advantages of CDMA and Spread Spectrum Techniques over FDMA and TDMA in Cellular Mobile Radio Applications," IEEE Trans. on Veh. Tech., Vol.42, No.3, pp.357-364, Aug. 1993.

[3] K.B.Letaif, "BER Estimation of Asynchronous DS/CDMA Communications Systems," ICC'95, pp.1340-1344, 1995.

[4] M.B.Pursley, "Performance Evaluation for Phase-coded Spread-Spectrum Multiple-Access Communication," IEEE Trans. on Commun., Vol.COM-25, No.8, pp.795-799, Aug, 1977.

[5] D.Makrakis, and K.M.Sundara Murthy, "Spread Slotted ALOHA Techniques for Mobile and Personal Satellite Communication Systems," IEEE JSAC., Vol.10, No.6, pp.985-1002, Aug. 1992.

[6] D.H.Davis, and S.A.Gronemeyer, "Performance of Slotted ALOHA Random Access with Delay Capture and Randomized Time of Arrival," IEEE Trans. on Commun., Vol.COM-28, No.5, pp.703-710, May 1980.

[7] Z.Zhang, and Y.J.Liu, "Performance Analysis of Multiple Access Protocols for CDMA Cellular and Personal Communications Services," IEEE INFOCOM'93, pp.1214-1221, 1993.

[8] E.Sousa, and J.A.Silvester, "Spreading Code Protocols for Distributed Spread-Spectrum Packet Radio Networks," IEEE Trans. on Commun., Vol.36, No.3, pp.272-280, Mar. 1988.

[9] L.Kleinlock, Queueing Systems Volume 1 : Theory, John Wiley & Sons, 1975.

[10] C.Namislo, "Analysis of Mobile Radio Slotted ALOHA Networks," IEEE JSAC, Vol.SAC-2, No.4, pp.583-588, Jul.1984.

REM 0087191

Exhibit 21

United States Patent [19]
Betts et al.

[11] **Patent Number: 4,677,625**
[45] **Date of Patent: Jun. 30, 1987**

[54] **DISTRIBUTED TRELLIS ENCODER**

[75] Inventors: **William L. Betts**, St. Petersburg; **Kenneth Martinez**, Pinellas Park; **Gordon Bremer**, Clearwater, all of Fla.

[73] Assignee: **Paradyne Corporation**, Largo, Fla.

[21] Appl. No.: **707,084**

[22] Filed: **Mar. 1, 1985**

[51] **Int. Cl.⁴** **G06F 11/10**; H03M 13/22

[52] **U.S. Cl.** .... **371/43**; 340/347 DD; 371/2; 375/26; 375/39

[58] **Field of Search** .... 340/347 DD; 371/43–45, 371/2; 360/39–42; 375/25, 34, 39

[56] **References Cited**

U.S. PATENT DOCUMENTS

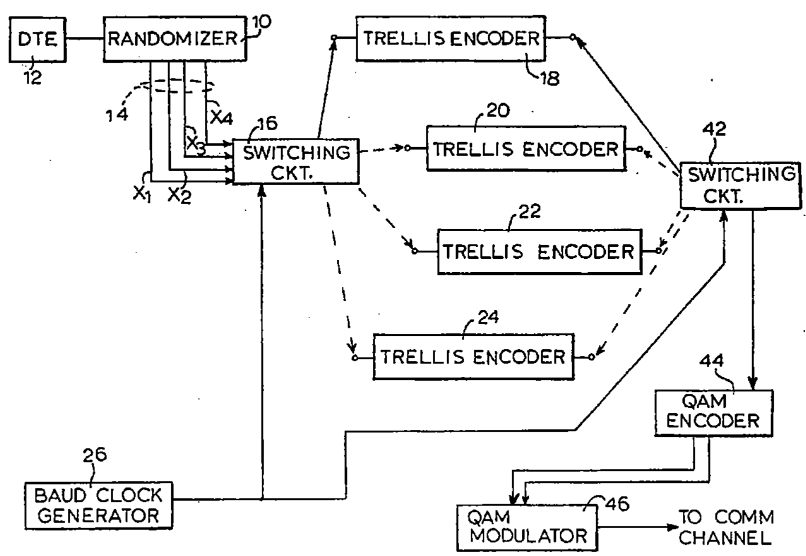
4,087,787 5/1978 Acampora 371/43
4,240,156 12/1980 Doland 371/43
4,500,994 2/1985 McCallister et al. 371/43
4,536,878 8/1985 Rattlingourd et al. 371/43

Primary Examiner—T. J. Sloyan
Attorney, Agent, or Firm—Kane, Dalsimer, Sullivan, Kurucz

[57] **ABSTRACT**

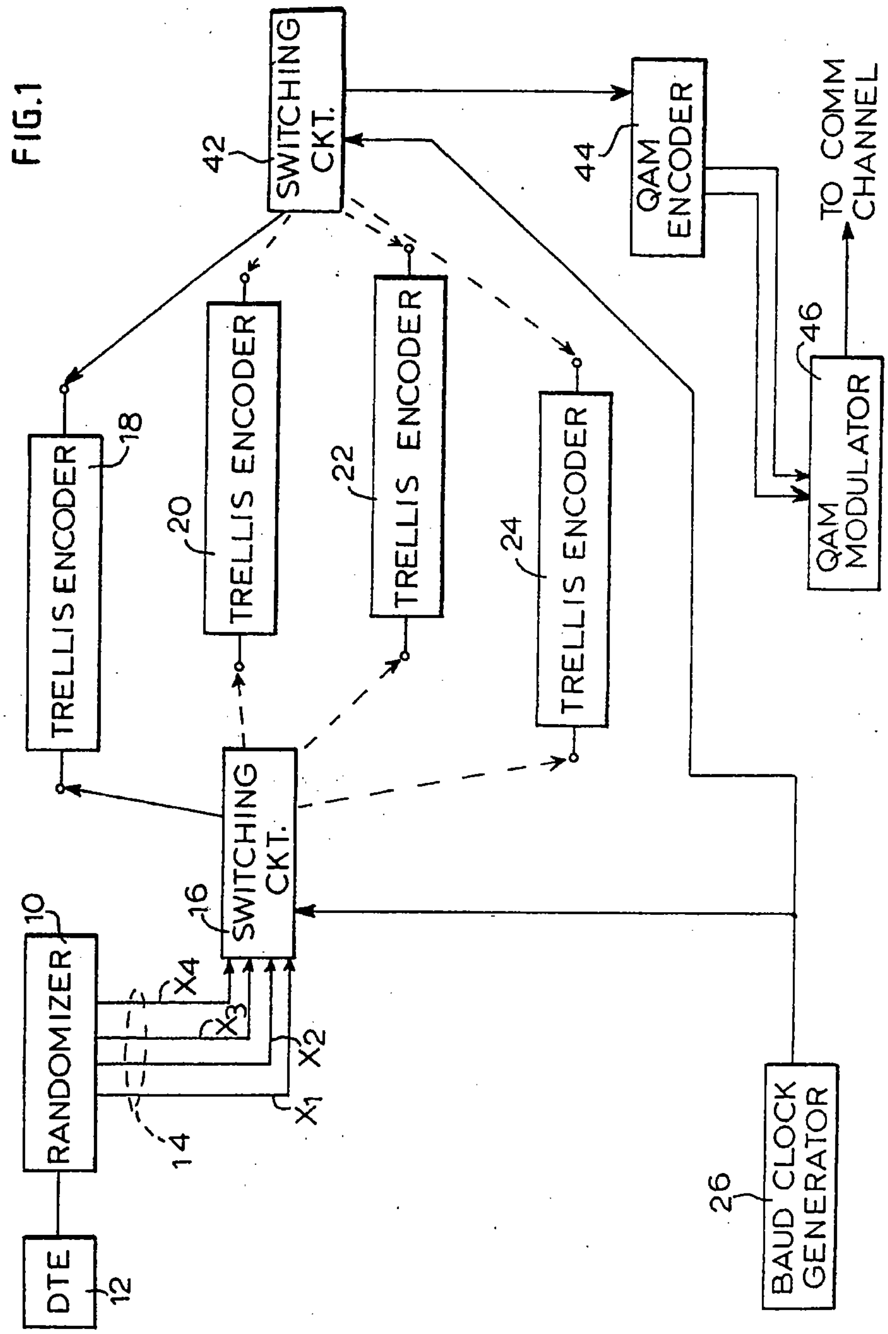
In the transmitter of a data communication system using QAM, a plurality of trellis coders with delay units are used for forward error correction. The output of each encoder is modulated using QAM to generate sequential baud signal elements. The redundant data bits generated are distributed between several non-consecutive bauds. Likewise, at the receiver a plurality of distributed convolutional decoders are utilized to decode the received signal element. The distributed trellis decoder is self-synchronizing.

11 Claims, 4 Drawing Figures



www.freepatentsonline.com

FIG.1



www.freepatentsonline.com

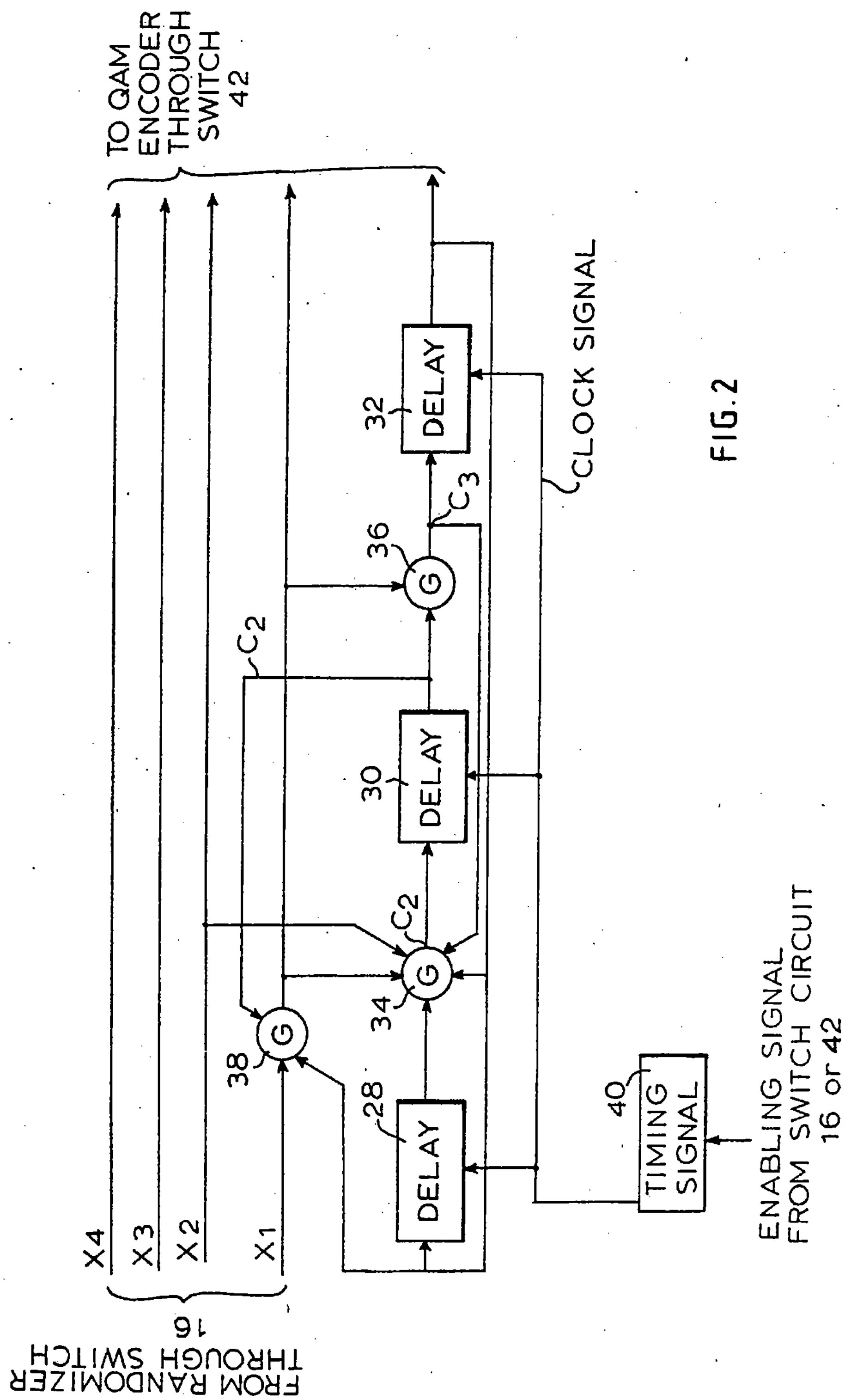
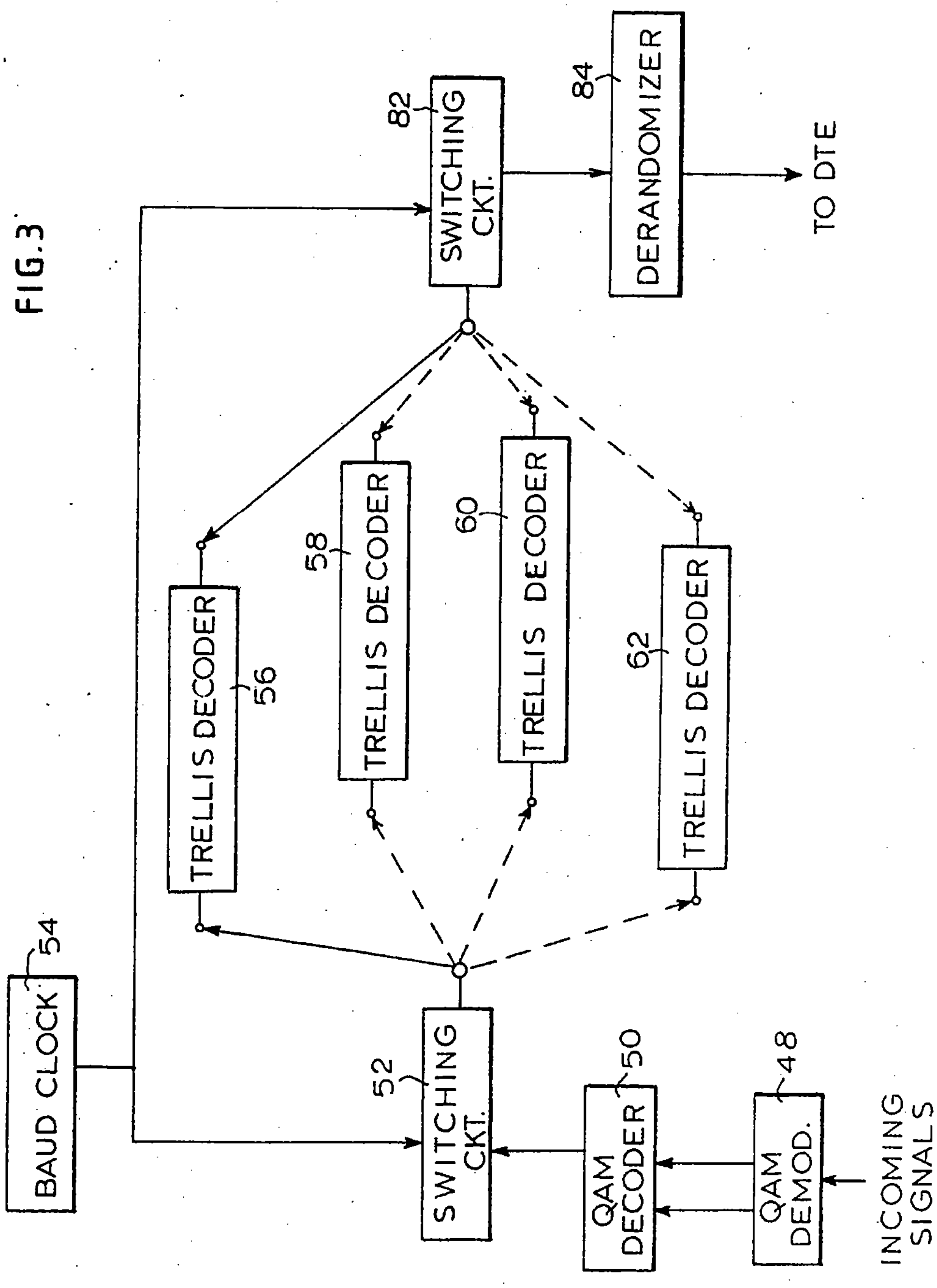


FIG. 2

www.freepatentsonline.com

FIG. 3



www.freepatentsonline.com

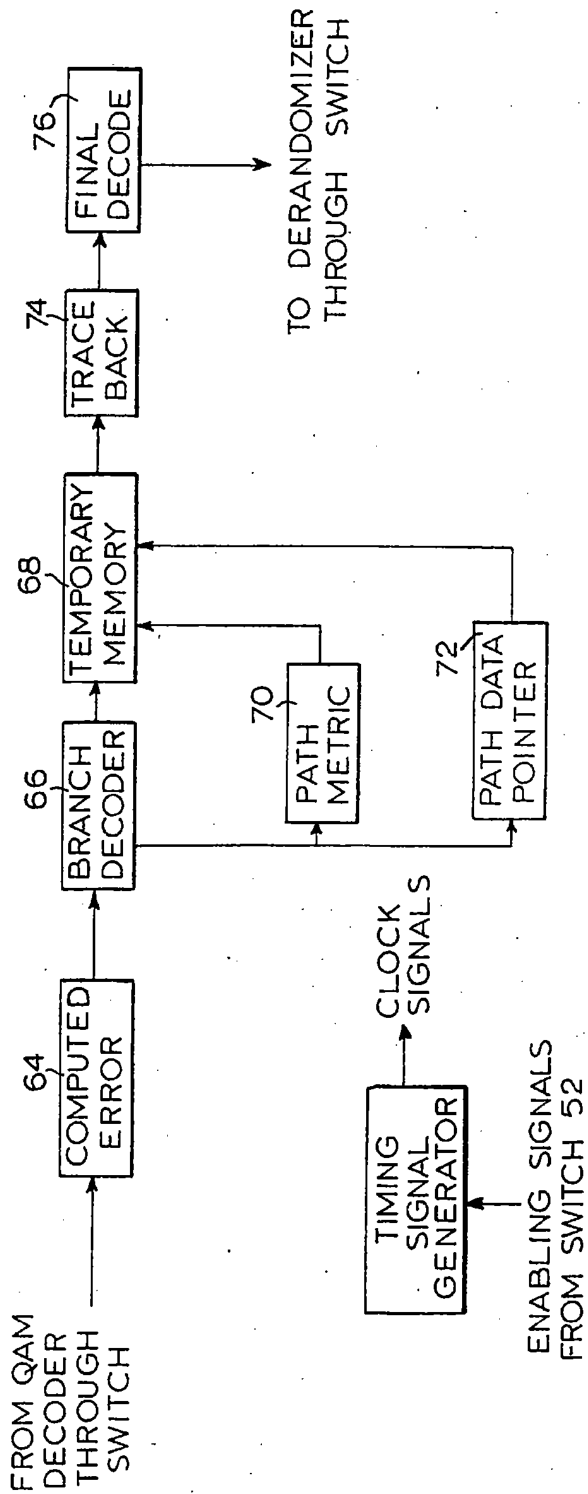


FIG. 4

www.freepatentsonline.com

DISTRIBUTED TRELLIS ENCODER

RELATED APPLICATIONS

The subject matter of this application is related to U.S. applications Ser. No. 707,085 entitled Self-Synchronizing Interleaver for Trellis Encoder used in Wireline Modems and Ser. No. 707,083 entitled Self-Synchronizing De-Interleaver for Viterbi Decoder Used in Wireline Modems, filed on even date herewith and incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention pertains to an apparatus and method of encoding binary bits and more particularly to a method and apparatus for making use of a forward error correction scheme for a reduced number of errors at a given signal-to-noise ratio.

2. Description of the Prior Art

Communication networks using high speed data rates require high signal-to-noise ratios for proper data transmission. Numerous schemes and combinations thereof have been proposed to reduce the number of errors at these given signal-to-noise ratios. For example, in U.S. Pat. No. 4,077,021 to Csajka et al a forward error correcting scheme is described making use of the so-called Viterbi algorithm. In a further development described by the CCITT study group XVII, Contribution No. D180, in October, 1983, entitled TRELLIS-CODED MODULATION SCHEME WITH 8-STATE SYSTEMATIC ENCODER AND 90 SYMMETRY FOR USE IN DATA MODEMS TRANSMITTING 3–7 BITS PER MODULATION INTERVAL a two-dimensional trellis for a quadrature amplitude modulation scheme is disclosed having 90° symmetry which results in a 4db gain in the signal-to-noise ratio. Typically, in forward error coding, redundant bits are added systematically to the data bits so that normally only predetermined transitions from one sequential group of bits (corresponding to bauds) to another are allowed. There is an inherent correlation between these redundant bits over consecutive bauds. At the receiver each baud is tentatively decoded and then analyzed based on past history, and the decoded bits are corrected if necessary. However, it was found that certain types of relatively long error signals, such as for exmaple, low frequency phase jitter, cause a constant phase error in the signal constellation for extended (consecutive baud) periods of time. This type of error prevents or inhibits the correction of the received bits using the schemes described above.

OBJECTIVES AND SUMMARY OF THE INVENTION

A principal objective of the present invention is to provide a device and method for data communication in which the effects of long bursts of error signals such as low frequency phase jitter are minimized.

A further objective is to provide a method of adapting a standard modem to perform the subject method and to provide a method that is self-synchronizing.

Other objectives and advantages of the invention shall become apparent from the following description of the invention.

In the present invention the correlation of the redundant bits of different baud signals is distributed in time prior to encoding at the transmitter. A distributed trellis

encoding scheme is used to obtain the redundant bits. At the receiver the received bauds are decoded using a plurality of distributed decoders which extract samples from multiple bauds for trellis decoding. The result is similar to that achieved by interleaving but avoids synchronization problems associated with the conventional complex interleaving processes.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** shows the elements of a data transmitter constructed in accordance with the invention;

FIG. **2** shows the elements of a distributed trellis encoder;

FIG. **3** shows the elements of a receiver for receiving data from the transmitter of FIG. **1**; and

FIG. **4** shows the elements of a distributed trellis decoder.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. **1**, a transmitter according to this invention comprises a randomizer **10** which receives serially a stream of data bits from DTE **12**. The randomizer scrambles the bits in a preselected pattern and generates randomized bits on parallel output lines **14** identified as X1, X2, X3 and X4.

These output lines are fed by an electronic switching circuit **16** to a plurality of identical trellis encoders **18**, **20**, **22** and **24**.

The electronic switching circuit **16** switches the signals from the randomizer **10** to one of the trellis encoders **18**, **20**, **22** and **24**, in accordance with a baud clock signal generated by baud clock generator **26**. In other words, for each baud period all the randomizer outputs X1, X2, X3 and X4 are fed to one of the encoders. Details of the trellis encoders **18**, **20**, **22** and **24** are shown in FIG. 2.

Each encoder comprises three delay units **28**, **30** and **32** which are adapted to generate a delay of one baud period. The encoder further comprises three gates **34**, **36** and **38**. These gates may be for example XOR (exclusive -OR) gates.

The trellis encoder shown in FIG. **2** is well known in the art and need not be described any further. Preferably all the elements of the encoder are digital elements which are enabled by appropriate clocking signals from timing signal generator **40**. The timing signal generator is enabled only when it receives an appropriate signal from switching circuit **16**. Thus each encoder is active only when it is addressed by switching circuit **16**. At all other times, the trellis encoders are idle.

Outputs Y0, Y1, X2, X3 and X4 are fed from the respective trellis encoders by a second electronic switching circuit **42** to QAM (quadrature amplitude modulation) encoder **44**. Switching circuit **42** is also enabled by baud clock generator **26** so that it operates simultaneously with switching circuit **16**. QAM encoder **44** selects a point of a preselected signal constellation corresponding to the inputs from circuit **42** and generates an in-phase and a quadrature output signal corresponding to said point. These output signals are fed to a QAM modulator **46** which generates corresponding analog QAM signals having a baud period equal to the period of the signals generated by signal generator **26**. The signals from modulator **46** are transmitted over a common data communication channel to a receiver.

www.freepatentsonline.com

In effect the bits of several consecutive signals are spaced out over several bauds by the distributed trellis encoders.

At the receiver, illustrated in FIG. 3, the incoming analog signals are demodulated by a QAM demodulator 48 which generates an in-phase and a quadrature signal which are fed to a QAM decoder 50. The QAM decoder 50 selects a point on the signal constellation closest to the actual point corresponding to the signals received from QAM demodulator 48. The bits corresponding to said point are sent to a third electronic switching circuit 52 having a period equal to the baud period of the received signals. Circuit 52 accesses sequentially one of four distributed trellis decoders 56, 58, 60 and 62 in response to the switching signal from generator 54. Thus all the binary signals from QAM decoder 50 corresponding to each received QAM signal are sent to one of the trellis decoders. The four trellis decoders are standard decoders well known in the art. One such decoder is shown in FIG. 4.

In a typical trellis decoder, the signals from the QAM decoder (in the present case, via switching circuit 52) are fed into an error computer circuit 64 which generates an error signal based on previously received signals. This error signal is fed to a branch decoder 66. The branch decoder uses the trellis branch rules (predetermined in accordance with the Viterbi algorithm) to generate a set of possible points corresponding to the received point. These set of points are stored in temporary memory 68. The decoder then searches through the points of the set to calculate the point with the smallest errors in accordance with appropriate constants stored in the path metric memory 70 and path pointer memory 72. The smallest error is used by trace back memory 74 to track back the last 4–16 bauds (in accordance with a preselected well-known scheme) to generate the final received point. The final received point of the set of points in memory 68 is fed to final decoder 76 as the received point.

As with the encoder of FIG. 2, each decoder comprises digital elements which are enabled by a timing signal generator 78.

The timing signal generator is enabled by an appropriate signal from switching circuit 52 only when the respective decoder is addressed by the switching circuit. Generator 78 generates clocking signals for the various decoder elements. Thus each decoder 56, 68, 60 and 62 is active only when it is addressed by switching circuit 52, and otherwise it is idle.

The output of each decoder is accessed sequentially by a fourth electronic switching circuit 82 which is synchronized by the baud clock generator 54 so that it is in step with switching circuit 52. In other words, each trellis decoder is accessed simultaneously by switch circuits 52 and 82. The switching circuit 82 feeds the signals from the decoders to derandomizer 84 for reversing the effects of randomizer 10 and then to a user DTE.

It can be seen from the above description that switching circuits 16 and 52 acts as multiplexers while switch circuits 42 and 82 act as demultiplexers. The effect of this switching is to interleave the data bits at the transmitter across four bauds, and deinterleave these bits at the receiver. Obviously the trellis encoders are self-synchronized so that no synchronizing signals are needed between the transmitter and receiver

In the above description consecutive bits are interleaved across four bauds by using four distributed trellis encoders and decoders. Obviously if more encoders and decoders are used the number of bauds over which interleaving occurs increases.

It should be appreciated that the invention makes use of standard QAM encoders, modulators, decoders, demodulators and standard trellis encoders and decoders which are well known in the art. Furthermore, while baud clock generators 26 and 54 are described as separate elements, in practice they can be incorporated in the QAM modulator and demodulator respectively. All the circuits of FIGS. 1 and 3 may be implemented by using a digital microprocessor.

Obviously, numerous modifications to the subject application may be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A data transmission section for a modem coupled to a channel for sending data signals comprising:

1. A plurality of trellis encoders, each trellis encoder having an input for receiving n plain text bits, each encoder being provided to interleave bits received by the encoder during a first baud period with bits received during more than two previous baud periods to generate n trellis encoded bits, k, being larger than one; in a single baud period, each trellis encoder having means for delaying at least some of said n plain text bits so that they may be outputted and combined with bits outputted from one or more other trellis encoders during single baud periods;
2. encoder activating means for selectively activating only one of said trellis encoders for one baud period in a preselected sequence whereby bits received during a baud period i are interleaved with bits received during a baud period i-k;
3. signal encoding means for converting encoded bits into signals suitable for transmission over said channel; and
4. transmitter switching means for feeding n plain text bits per baud period to the activated trellis encoder and for sending the encoded bits from the activated trellis encoder to the signal encoding means.

2. A receiver section for a modem receiving data signals from a channel, said signals having been trellis encoded by interleaving bits corresponding to a baud period i with bits corresponding to a baud period i-k, k being larger than two, and having:

1. a demodulator and a decoder connected to the output of said demodulator for converting analog data signals from said channel into multiple series of bits, each series of bits substantially corresponding to a point of said analog data signal's preselected signal constellation;
2. k trellis decoders, each trellis decoder having an input from said decoder for receiving series of bits from said decoder and generating n bits of plain text bits corresponding to n bits received at least during two previous baud periods;
3. decoder activating means for activating only one of said trellis decoders during one baud period in another predetermined sequence; and
4. receiver switching means for feeding n encoded bits to the activated decoder and for collecting n plain text bits from the activated decoder.

3. A method of transmitting a plurality of input data bits over a channel by quadrature amplitude modulator comprising:

www.freepatentsonline.com

providing a plurality of trellis encoders, each encoder using an identical scheme to interleave bits received during a first baud period with bits received during more than two earlier baud periods preceding said first baud period to generate output bits;

activating each of said trellis encoders in a preselected order for a baud period;

feeding bits which occur during a single baud period to only one of said plurality of trellis encoders;

delaying at least some of said bits in said one trellis encoder during a single baud period;

combining bits which have been outputted from said one trellis encoder with bits which have been outputted from one or more different trellis encoders for transmission during a single baud period; and

quadrature amplitude modulating output bits of each activated trellis encoder.

4. A system for transmitting data signals over a data channel comprising:

a. a data transmission section coupled to said channel for sending data signals and having:

1. A plurality of trellis encoders, each trellis encoder having an input for receiving n plain text bits each encoder being provided to combine bits received by the encoder during more than two previous baud periods with bits received during a previous baud period to generate n trellis encoded bits in a single baud period, each trellis encoder having means for delaying at least some of said n plain text bits so that they can be outputted and combined with bits outputted from one or more other trellis encoders during single baud periods;
2. encoder activating means for selectively activating only one of said trellis encoders for one baud period in a preselected sequence;
3. signal encoding means for converting encoded bits into signals suitable for transmission over said channel; and
4. transmitter switching means for feeding n plain text bits per baud period to the activated trellis encoder and for sending the encoded bits from the activated trellis encoder to the signal encoding means; and

b. a receiver section for receiving data signals from said channel, and having:

1. a demodulator and a decoder connected to the output of said demodulator for converting analog data signals from said channel into multiple series of bits, each series of bits substantially corresponding to a point of said analog data signal's preselected signal constellation of;
2. a plurality of trellis decoders equal in number to the trellis encoders, each decoder generating n bits of plain text bits corresponding to n bits received by the encoder during a baud period and n bits received at least during a previous baud period;
3. decoder activating means for activating only one of said trellis decoders during one baud period in another predetermined sequence; and
4. receiver switching means for feeding n bits to the activated decoder and for collecting n plain text bits from the activated decoder.

5. The system of claim **4** wherein said transmitter switching means comprises a first transmitter switch for providing input bits to the activated trellis encoder, and a second transmitter switch for providing encoded bits from the activated trellis encoder to the signal encoding means.

6. The system of claim **5** wherein said signal encoding means comprises a quadrature amplitude modulator.

7. The system of claim **6** wherein said signal decoding means comprises a quadrature amplitude demodulator.

8. The system of claim **7** wherein there are k trellis encoders each trellis encoders including several delay elements for combining the bits received during said one baud periods with bits received during several preceding baud periods each preceding baud period being separated from the next baud period by $(k-1)$ D seconds where D is the duration of a period.

9. The system of claim **7** wherein said receiver switching means comprises a first receiver switch for feeding encoded bits to the activated decoders and a second receiver switch for collecting plain text bits from the activated decoders.

10. The system of claim **7** wherein each period has a time duration of D seconds and each encoder includes a delay element for delaying bits received during a baud period by D seconds.

11. The method of claim **3** further comprising providing a plurality of trellis decoders for sequentially decoding transmitted signals, each trellis decoder being activated sequentially for a baud period for deinterleaving said signals.

* * * * *

www.freepatentsonline.com

Case 2:07-cv-00438-FJM Document 1 Filed 02/18/2007 Page 1 of 15

<u>Exhibit 22</u>

US005706312A

United States Patent [19]

Wei

[11] Patent Number: 5,706,312

[45] Date of Patent: Jan. 6, 1998

[54] TRELLIS CODED MODULATION EMPLOYING LOWER DIMENSIONALITY CONVOLUTIONAL ENCODER

[75] Inventor: Lee-Fang Wei, Lincroft, N.J.

[73] Assignee: Lucent Technologies Inc., Murray Hill, N.J.

[21] Appl. No.: 840,438

[22] Filed: Mar. 31, 1997

Related U.S. Application Data

[63] Continuation of Ser. No. 321,363, Oct. 11, 1994, abandoned.

[51] Int. Cl.[6] H04L 5/12; H03M 13/12

[52] U.S. Cl. 375/298; 375/265; 371/43

[58] Field of Search 375/262, 264, 375/265, 286, 295, 298, 340–341; 371/37.5, 37.8, 43

[56] References Cited

U.S. PATENT DOCUMENTS

4,660,214	4/1987	Pavlavan et al.	375/265 X
4,941,154	7/1990	Wei	375/265
4,980,897	12/1990	Decker et al.	375/265
5,233,629	8/1993	Pair et al.	375/265 X
5,248,646	9/1993	Eyuboglu	375/354
5,321,725	6/1994	Pair et al.	375/265
5,363,408	11/1994	Pair et al.	375/261
5,398,073	3/1995	Wei	348/487
5,442,626	8/1995	Wei	370/20

OTHER PUBLICATIONS

"Trellis–Coded Modulation with Multidimensional Constellations" IEEE Trans. on Info. Theory, vol. IT–33, No. 4, Jul. 1987, pp.483–501.

"Trellis–Coded Modulation with Redundant Signal Sets Part 1: Introduction, and IEEE Communications, Feb. 1987, vol. 25, No. 2 pp. 5–21 Part II State of the Art".

Primary Examiner—Young T. Tse
Attorney, Agent, or Firm—R. D. Slusky

[57] ABSTRACT

Coding gain is improved by employing an N-dimensional trellis encoder incorporating an N'-dimensional convolutional encoder where N' is less than N. The additional coding gain is realized as a shaping gain. This unique modulator encodes a digital signal by generating a sequence of N-dimensional symbols as a function of the digital signal using an N'-dimensional convolutional encoder within the trellis encoder more than once (integer N/N' times) during each N-dimensional symbol interval. This allows the trellis encoder to produce an output of higher dimensionality than would normally be expected from the lower dimensionality convolutional encoder. The trellis encoder is applicable to television transmission.

47 Claims, 6 Drawing Sheets

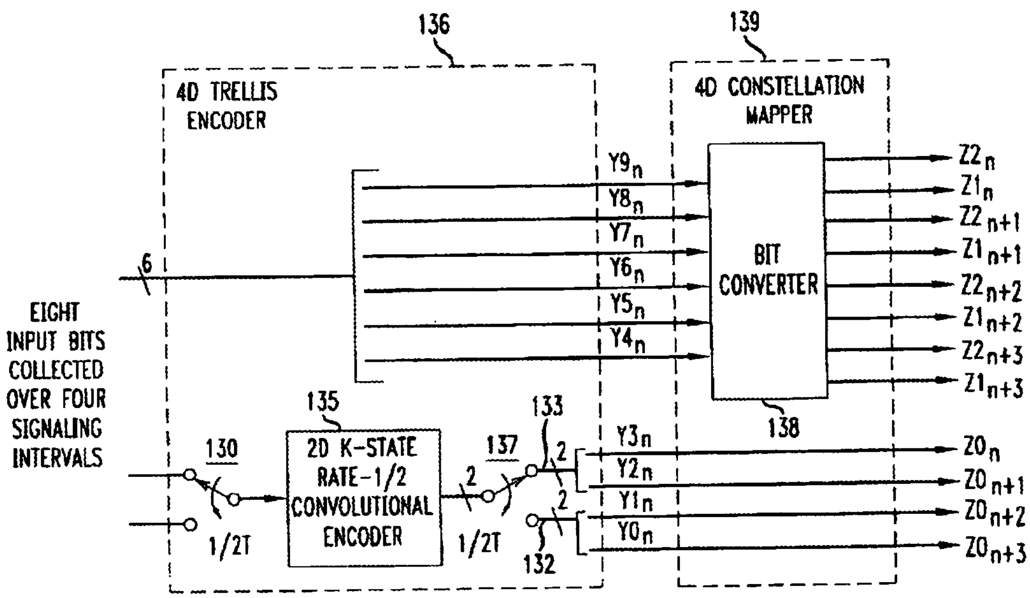
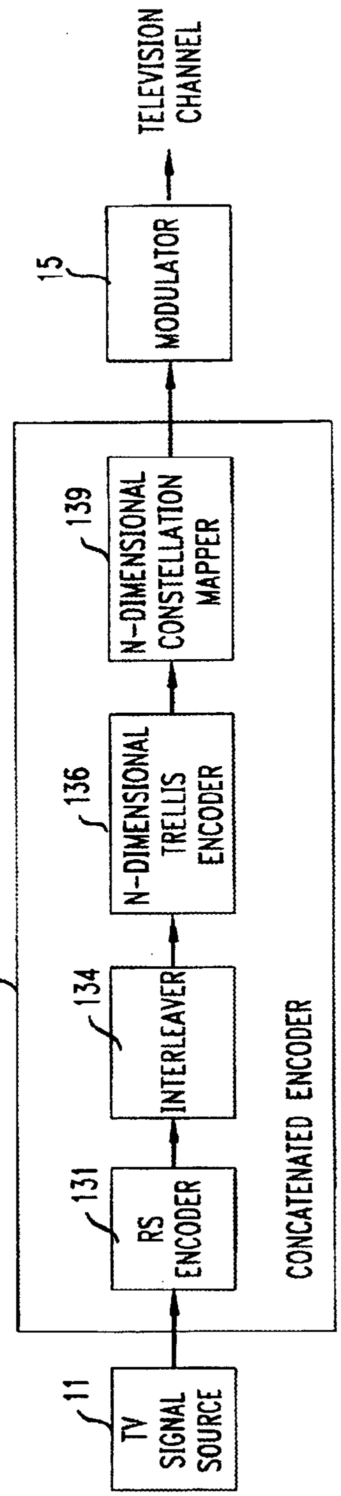


FIG. 1



TV SIGNAL SOURCE
11
RS ENCODER
131
INTERLEAVER
134
N-DIMENSIONAL TRELLIS ENCODER
136
N-DIMENSIONAL CONSTELLATION MAPPER
139
CONCATENATED ENCODER
13
MODULATOR
15
TELEVISION CHANNEL

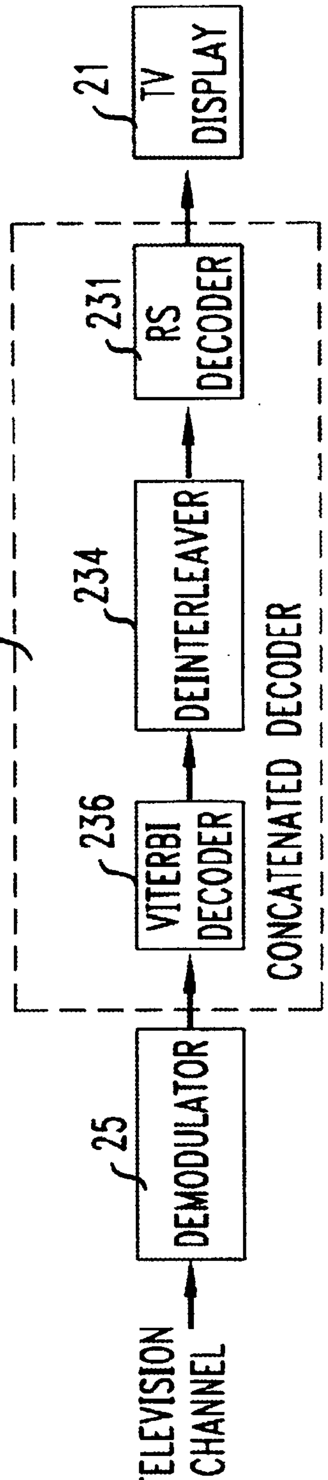

TV DISPLAY
21
RS DECODER
231
DEINTERLEAVER
234
23
VITERBI DECODER
236
CONCATENATED DECODER
DEMODULATOR
25
TELEVISION CHANNEL

FIG. 2

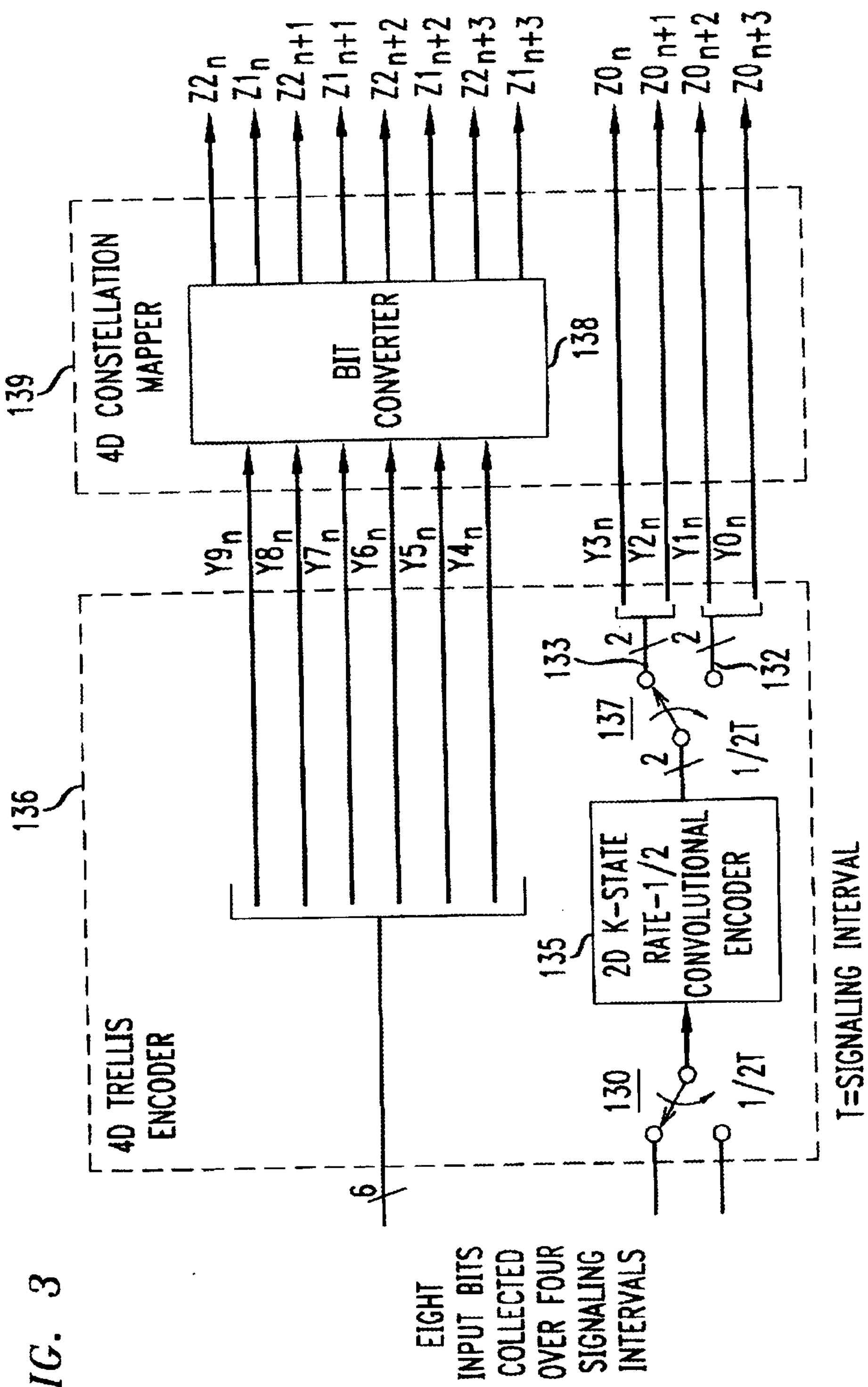

4D CONSTELLATION MAPPER
139
BIT CONVERTER
138
$Z2_n$
$Z1_n$
$Z2_{n+1}$
$Z1_{n+1}$
$Z2_{n+2}$
$Z1_{n+2}$
$Z2_{n+3}$
$Z1_{n+3}$
$Z0_n$
$Z0_{n+1}$
$Z0_{n+2}$
$Z0_{n+3}$
$Y9_n$
$Y8_n$
$Y7_n$
$Y6_n$
$Y5_n$
$Y4_n$
$Y3_n$
$Y2_n$
$Y1_n$
$Y0_n$
136
4D TRELLIS ENCODER
6
135
2D K-STATE RATE-1/2 CONVOLUTIONAL ENCODER
130
1/2T
137
2
133
132
T=SIGNALING INTERVAL
EIGHT INPUT BITS COLLECTED OVER FOUR SIGNALING INTERVALS

FIG. 3

FIG. 4

$Y9_nY8_nY7_nY6_nY5_nY4_n$	$Z2_nZ1_n$	$Z2_{n+1}Z1_{n+1}$	$Z2_{n+2}Z1_{n+2}$	$Z2_{n+3}Z1_{n+3}$
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16	2	0	0	0
17	2	0	0	1
18	2	0	1	0
19	2	0	1	1
20	0	2	0	0
21	0	2	0	1
22	0	2	1	0
23	0	2	1	1
24	0	0	2	0
25	0	1	2	0
26	1	0	2	0
27	1	1	2	0
28	0	0	0	2
29	0	1	0	2
30	1	0	0	2
31	1	1	0	2
32	2	1	0	0
33	2	1	0	1
34	2	1	1	0
35	2	1	1	1
36	1	2	0	0
37	1	2	0	1
38	1	2	1	0
39	1	2	1	1
40	0	0	2	1
41	0	1	2	1
42	1	0	2	1
43	1	1	2	1
44	0	0	1	2
45	0	1	1	2
46	1	0	1	2
47	1	1	1	2
48	2	0	2	0
49	2	0	2	1
50	2	0	0	2
51	2	0	1	2
52	0	2	2	0
53	0	2	2	1
54	0	2	0	2
55	0	2	1	2
56	2	1	0	2
57	2	1	2	0
58	1	2	0	2
59	1	2	2	0
60	2	2	0	1
61	2	2	1	0
62	0	1	2	2
63	1	0	2	2

FIG. 5

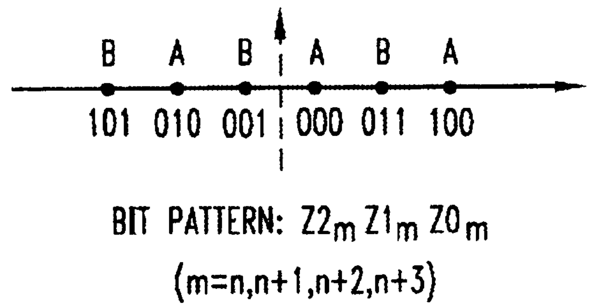


FIG. 6

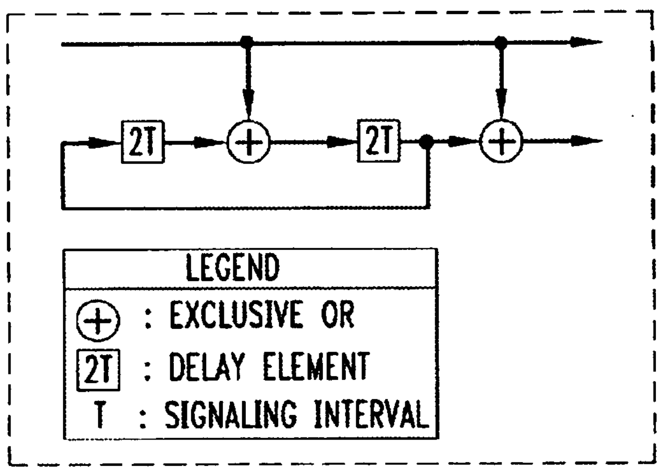


FIG. 7

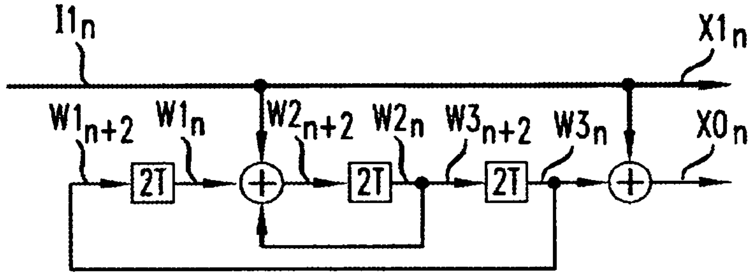


FIG. 8

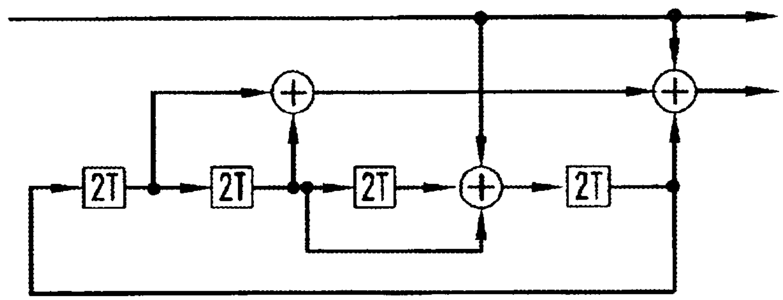


FIG. 9

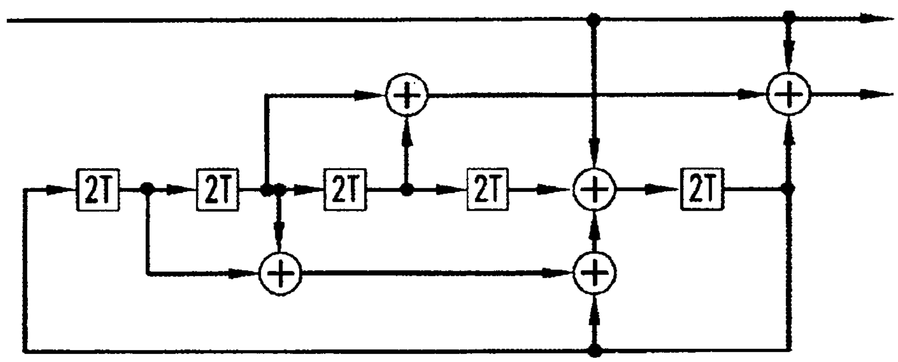
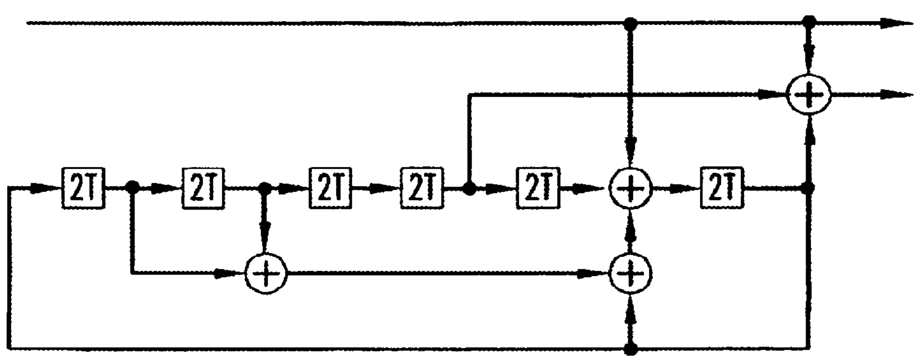


FIG. 10



Case 2:07-cv-00439-FCD-CMK Document 1-3 Filed 03/28/2007 Page 9 of 15

TRELLIS CODED MODULATION EMPLOYING LOWER DIMENSIONALITY CONVOLUTIONAL ENCODER

This application is a continuation of application Ser. No. 08/321,363, filed on Oct. 11, 1994, now abandoned.

TECHNICAL FIELD

This invention relates to trellis coded modulation and its application to television systems.

BACKGROUND OF THE INVENTION

Trellis coded modulation schemes have been shown to improve error performance of data links without sacrificing data rate or requiring additional bandwidth. Generally speaking, an N-dimensional trellis coded modulation scheme is constructed by first partitioning an N-dimensional constellation into a number of subsets. The input to the trellis coded modulation scheme in each N-dimensional symbol interval is divided into two portions. A first portion is input to an N-dimensional convolutional encoder whose output bits are used to identify an N-dimensional subset of the constellation. In this case, the convolutional encoder operates only once during each N-dimensional symbol interval. The second portion of input bits remains uncoded and is used to further specify an N-dimensional symbol from the identified N-dimensional subset. The bits identifying both the N-dimensional subset and the N-dimensional symbol are supplied to an N-dimensional constellation mapper. The constellation mapper converts the input bits into an N-dimensional symbol or J P-dimensional signal points, where J and P are integers whose product equals N.

In the prior art, the trellis coded modulation has a dimensionality which is equal to the dimensionality of its associated convolutional encoder. This is the generally accepted design in the art.

Trellis coded modulation has recently been recommended for use in high definition television (HDTV). In an approach proposed by Zenith Corporation to the FCC, the proposed modulation scheme utilizes a concatenated coded, vestigial sideband (VSB) modulator. In the concatenated coder, a Reed-Solomon code is used as an outer code followed by a one dimensional, four state trellis code as an inner code. The VSB modulator uses an eight symbol, one-dimensional constellation. For each successive transmission symbol period, the concatenated coder identifies a particular one of the eight one-dimensional VSB symbols to be transmitted. In this application to HDTV, the trellis coded modulation and its associated convolutional encoder have identical dimensionalities—both are one dimensional. Also, in allowed U.S. patent application Ser. No. 08/226,606, now U.S. Pat. No. 5,398,073 issued Mar. 14, 1995 and in U.S. patent application Ser. No. 08/276,079, higher-dimensional trellis coded modulators and convolutional encoders are used. But consistent with prior art practices, the dimension of the trellis coded modulator is equal to the dimension of its associated convolutional encoder.

SUMMARY OF THE INVENTION

Coding gain is improved in accordance with the principles of the present invention by employing an N-dimensional trellis coded modulator incorporating an N'-dimensional convolutional encoder where N' is less than N. The additional coding gain is realized as a shaping gain. This unique modulator encodes a digital signal by generating a sequence of N-dimensional symbols as a function of the digital signal using an N'-dimensional convolutional encoder within the trellis coded modulator more than once (integer N/N' times) during each N-dimensional symbol interval. This allows the trellis coded modulator to produce an output of higher dimensionality than would normally be expected from the lower dimensionality convolutional encoder.

In a specific embodiment of the invention, a two-dimensional (2D) convolutional code is used in a four-dimensional (4D) trellis coded modulation scheme. The trellis coded modulator uses four-dimensional constellation mapping.

In another embodiment, the N-dimensional trellis encoder is used as the inner coder of a concatenated code while an N-dimensional constellation mapper converts the coder output into a sequence of N-dimensional symbols or J P-dimensional signal points where J and P are integers whose product is N. Each P-dimensional signal point is transmitted in a so-called "signalling interval." J P-dimensional signal points are then transmitted in an N-dimensional symbol interval.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be obtained by reading the following description of specific illustrative embodiments of the invention in conjunction with the appended drawing in which:

FIG. 1 is a block diagram of a television transmitter incorporating principles of the present invention;

FIG. 2 is a block diagram of a television receiver incorporating principles of the present invention;

FIG. 3 shows a specific implementation of a 4D trellis coded modulator employing a 2D convolutional encoder;

FIGS. 4 and 5 show details of a 4D constellation mapper for use with the 4D trellis coded modulator in FIG. 3; and

FIGS. 6–10 show specific 2D, rate ½ convolutional encoders.

DETAILED DESCRIPTION

FIG. 1 shows a block diagram of a television transmitter incorporating a trellis coded modulator realized in accordance with the principles of the present invention. The television transmitter includes TV signal source 11, concatenated encoder 13 and modulator 15.

A television signal such as an HDTV signal is supplied to the concatenated encoder by TV signal source 11. TV signal source 11 includes compression and formatting circuits as well as scrambling circuitry for rearranging the bit stream in a random order.

Concatenated encoder 13 includes the serial combination of Reed-Solomon encoder 131, interleaver 134, N-dimensional trellis encoder 136, and N-dimensional constellation mapper 139. Reed-Solomon encoder 131 is an outer encoder of the concatenated code while an N-dimensional trellis encoder 136 is the inner encoder of concatenated encoder 13. Interleaver 134 operates in a conventional manner to reorder the sequence of Reed-Solomon symbols from encoder 131 thereby providing burst error protection in the receiver. Trellis encoder 136 generates output bits which identify a symbol in an N-dimensional constellation in each N-dimensional symbol interval. It is contemplated that an N-dimensional symbol be transmitted as a sequence of J P-dimensional signal points where J and P are integers whose product is N. N-dimensional constellation mapper 139 converts the modulator output into a

specific N-dimensional symbol or sequence of J P-dimensional signal points according to a prescribed set of mapping rules. One such set of rules is shown in FIGS. 4 and 5.

Symbols output by concatenated encoder 13 are supplied to modulator 15 for transmission over the television channel. While many modulation schemes are applicable to modulator 15, quadrature amplitude modulation (QAM) and the vestigial sideband modulation (VSB) are presently the modulation techniques of choice for HDTV application. It should be noted that the input to an M-ary VSB modulator is a sequence of one-dimensional (P=1) signal points whereas the input to a QAM modulator is a sequence of two-dimensional (P=2) signal points. In the description which follows, it will be assumed that modulator 15 is an M-VSB modulator. The symbol "M" indicates that the amplitude of the VSB signal can assume any one of M different values. As such, M is the size of the one-dimensional transmitter constellation implemented by the modulator.

Modulator 15 not only includes standard modulation circuitry, but also includes an interleaver for rearranging the sequence of signal points in such a way that successive signal points generated by concatenated encoder 13 will not appear in succession on the television channel. This additional interleaving insures optimal performance of the convolutional decoder described below. Modulator 15 may also include a Tomlinson precoder as discussed in U.S. patent application Ser. No. 08/276,079, whose teachings are expressly incorporated herein by reference.

Signals output by modulator 15 are applied to a television channel. Exemplary television channels are cable or an over-the-air channel. Signals on a television channel are received by the receiver shown in FIG. 2.

The received signal is applied to demodulator 25. Demodulator 25 performs the inverse operation of each component in modulator 15. For example, demodulator 25 may include a VSB demodulator, an NTSC rejection filter, a channel equalizer, and a de-interleaver. The latter element is used to restore signal points to their original order for subsequent decoding.

The output of demodulator 25 is applied to concatenated decoder 23. Concatenated decoder 23 includes Viterbi decoder 236, de-interleaver 234, and Reed-Solomon decoder 231. Viterbi decoder 236 performs convolutional decoding by the well-known Viterbi decoding technique. The output of decoder 236 is a sequence of interleaved Reed-Solomon symbols. Those symbols are restored to their original order by de-interleaver 234, which performs the inverse operation of interleaver 134. Once in the proper order, the symbols are decoded by Reed-Solomon decoder 231. TV display 21 receives the output of Reed-Solomon decoder 231. The display includes standard circuitry for decompressing (expanding) and reformatting the television signal for presentation on a CRT or other suitable viewing screen.

In the context of the present invention, it will be appreciated by persons skilled in the art that the Viterbi decoder has the same dimensionality as the convolutional encoder in the trellis code modulator. That is, the Viterbi decoder is N' dimensional. This means that the Viterbi decoder, during each processing cycle, processes an N' dimensional input. If the receiver receives P-dimensional inputs, then a sufficient number of those P-dimensional inputs are concatenated to form the N'-dimensional input to the Viterbi decoder. The bits output by the Viterbi decoder are collected over an entire symbol interval and together are mapped into the bits that correspond to the input to the trellis encoder during the associated N-dimensional symbol interval.

It will be understood by those skilled in the art, although not explicitly shown or described herein, synchronization signals are periodically inserted by modulator 15 into the data stream it receives from concatenated encoder 13. Demodulator 25 recognizes the synchronization signals and responsively generates synchronization control signal which is used by the television receiver to synchronize receiver operations, where necessary, with corresponding transmitter operations.

In various illustrative embodiments, the Reed-Solomon encoder utilizes a so-called RS(208,188) code over GF(256). This means that each Reed-Solomon codeword has 188 data symbols and 20 redundant symbols where each symbol consists of 8 bits. Depending on the degradation of transmission on a television channel, more-or less-powerful Reed-Solomon codes can be selected by balancing the need for a particular error-correcting capability against the need for a particular bit rate.

An exemplary 4-dimensional trellis code modulator using a 6-VSB transmitter constellation realized in accordance with the principles of the invention is shown in FIGS. 3–5. In this exemplary embodiment, the trellis encoder is four-dimensional owing to the fact that its associated constellation mapper is four-dimensional and the convolutional encoder within the trellis code modulator is two-dimensional. In this FIG, the notation drawing a slash through a line and placing a number x above the slash is meant to indicate that there are x such input or output leads having the connections of the single line shown in the FIG.

Convolutional encoder 135 utilizes a 2D, K state, rate ½ convolutional code in this example. This encoder accepts one input bit in each pair of signalling intervals and produces two output bits. Since the input bits to trellis encoder 136 are actually collected over four signalling intervals in this example and because this creates two input bits for the convolutional encoder to handle, it is necessary to encode the bits sequentially and thereby produce the four output bits.

In the example depicted in FIG. 3, it is assumed that a first input bit supplied to the convolutional encoder during a symbol interval is collected during its (the symbol interval's) first pair of signalling intervals. Similarly, a second input bit supplied to the convolutional encoder during the same symbol interval is collected during its second pair of signalling intervals.

To this end, the convolutional encoder is augmented by elements 130 and 137, each shown schematically as a switch. Element 130 applies one of the available input bits to the encoder during the first pair of signalling intervals of a symbol interval. In the second pair of signalling intervals of the symbol interval, element 130 applies the second input bit to the convolutional encoder. Element 137 directs the output bits during one convolutional encoding cycle to output lead 133 and then switches the output during the next convolutional encoding cycle to output lead 132. The switching rate for elements 130 and 137 is denoted as 1/2T, where T is the signalling interval.

Constellation mapper 139 includes bit converter 138 and a plurality of straight-through connections. In this example, the outputs of convolutional encoder 135 are fed straight-through constellation mapper 139 to its output. Uncoded bits from trellis encoder 136 are supplied to bit converter 138. As shown in FIG. 3, bit converter 138 translates its six-bit input

into an eight-bit output. Bit converter **138** insures that each output bit is derived jointly and interdependently from the input bits. The output bits from constellation mapper **139** are then used to select a four-dimensional symbol or a sequence of four one-dimensional signal points from a 6-VSB transmitter constellation over the four signalling intervals identified in the subscripts as n, n+1, n+2, and n+3.

Operational and realization details of both the convolutional encoder and the bit converter shown in FIG. 3 are well known to persons skilled in this art and, as such, they will not be described further herein.

Each of the sixteen different possible bit patterns represented by the four bits output in each symbol interval from trellis encoder **136** identifies a respective subset of symbols of a four-dimensional constellation. The remaining six bits, so-called "uncoded," bits $Y4_n$ through $Y9_n$ further select a particular symbol from the identified four-dimensional subset.

In particular, the 4D constellation is formed by concatenating four 6-VSB 1D transmitter constellations. The 4D constellation is partitioned into sixteen four dimensional subsets based on a partitioning of its constituent one-dimensional transmitter constellations. FIG. 5 shows how the one-dimensional six-point VSB constellation is partitioned into two subsets, A and B, each subset having three one-dimensional signal points. Each 4D subset is simply a sequence of four 1D subsets. In addition, each 4D subset may be represented as a sequence of two 2D subsets. In the latter case, each 2D subset is merely a sequence of two 1D subsets.

The selection of a particular symbol from the identified four-dimensional subset proceeds as follows: The four bits $Y3_n$, $Y2_n$, $Y1_n$, and $Y0_n$, from convolutional encoder **135** are output by the constellation mapper as four bits, $Z0_n$, $Z0_{n+1}$, $Z0_{n+2}$, and $Z0_{n+3}$, respectively. These bits are then used to select the sequence of one-dimensional subsets which the bits identify.

There are actually 81 possible symbols in each one-dimensional subset sequence, as can be seen from the fact that each one-dimensional subset has three signal points, and $3^4=81$. However, since the six bits $Y4_n$ through $Y9_n$ can represent only 64 different bit patterns, not all of the 81 symbols will actually be used. Rather, it is advantageous for the lookup table of FIG. 4 to map the 64 input bit patterns into the 64 symbols sharing a common characteristic. For example, the symbols may be the smallest energy symbols (the energy of a symbol being simply given by the sum of the squares of the coordinates of its constituent one-dimensional signal points.) To this end, bits $Y4_n$ through $Y9_n$ are applied to bit converter **138** which implements the lookup table shown in FIG. **4**. The first pair of output bits of bit converter **138**—denoted $Z2_n$ and $Z1_n$—selects a signal point from the first subset of the one-dimensional subset sequence, which is identified by bit $Z0_n$. The second pair of output bits of encoder **138**—denoted $Z2_{n+1}$ and $Z1_{n+1}$—selects a signal point from the second subset of the one-dimensional subset sequence, which is identified by bit $Z0_{n+1}$, and so forth. FIG. **5** shows the mapping by which the bit values of $Z2_m$, $Z1_m$, and $Z0_m$, for m=n, n+1, n+2 and n+3 identify a particular one-dimensional signal point.

Examples of 2D, rate ½, K-state convolutional encoders suitable for use as encoder **135** are shown in FIG. **6** (K=4), FIG. **7** (K=8), FIG. **8** (K=16), FIG. **9** (K=32), and FIG. **10** (K=64). These encoders are useful as the convolutional encoder for trellis code modulator **136** in FIG. **3**.

Specifically, the operations of the convolutional encoder in FIG. **7** can be explicitly described as follows. In each pair of signalling intervals, designated by the index "n" for its first signalling interval, the encoder inputs a bit $I1_n$, makes a transition from its current state, $W1_n$, $W2_n$ $W3_n$, to a next state, $W1_{n+2}$ $W2_{n+2}$ $W3_{n+2}$, and outputs two bits $X1_n$, and $X0_n$ where $W1_n$, $W2_n$ and $W3_n$ are the bits stored in the delay elements at the beginning of the pair of signalling intervals, and $W1_{n+2}$, $W2_{n+2}$ and $W3_{n+2}$ are the bits stored in the delay elements at the end of the pair of signalling intervals, and

$X1_n = I1_n$

$X0_n = W3_{n \oplus X1n}$

$W1_{n+2} = W3_n$

$W2_{n+2} = W1_{n \oplus W2n \oplus I1n}$

$W3_{n+2} = W2_n$

Each convolutional code shown in FIGS. **6–10** is designed to maximize the minimum Hamming distance between the sequences of its encoded output bits. Trellis encoders employing these convolutional codes are desirable when concatenated with Reed-Solomon codes, for example. While the Hamming distance feature of the depicted codes is desirable in certain cases, there may be other features such as rotational invariance and the like which may be desirable for the convolutional codes. In any of the cases cited above, it is important to understand that, regardless of the features are selected for the code, the convolutional code must have a lower dimensionality than that of its associated trellis code modulator.

Other state sizes can be used for the convolutional encoder **135** of FIG. **3**. Although the exemplary codes are shown as s systematic codes, it is understood that non-systematic codes are equally applicable to the present invention.

It is contemplated that rates other than ½, dimensions other than 2, and other various state sizes can be employed in the convolutional encoder used by trellis encoder **136**.

In the example described above, VSB constellations have been employed causing P to be equal to 1. As such, each 4D symbol was constructed as a sequence of four 1D signal points. It should be understood that each 4D symbol could also be represented as a sequence of two 2D signal points. In the 6-VSB example, each 2D signal point can be represented as a sequence of two 1D signal points. At the receiver, the Viterbi decoder will process one such 2D point in each processing cycle.

As stated earlier, the present invention is applicable to other modulation systems such as QAM, for example. For the specific example described above, the 4D trellis code modulator will output a pair of 2D signal points in each symbol interval.

In the description above, the invention has been described in the context of integer bit rates. That is, the average number of input bits received in each symbol interval is an integer. In practice, however, it is understood that cases arise wherein the average number of input bits received in each symbol interval is a non-integer. For such cases, it is contemplated that the input to the trellis encoder will be adapted with a fractional bit encoder (not shown) to insure that an integer number of input bits is received by the trellis encoder in each symbol interval, as described in U.S. Pat. No. 4,941,154.

I claim:

1. A method of N-dimensional trellis coded modulation for encoding a digital signal, the method comprising the step of:

generating a sequence of N-dimensional symbols as a function of the digital signal using an N'-dimensional

convolutional encoder, where N>N'≧1, said encoder being used to generate for each of a plurality of N-dimensional signal intervals, a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, the N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point.

2. The method as defined in claim 1 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating further including the steps of:

applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and

using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

3. The method as defined in claim 2 wherein said subset of said N-dimensional constellation consists of a sequence of (N/N') N'-dimensional subsets, wherein each N'-dimensional subset is identified by the convolutional encoder output for a particular group of bits.

4. A method of concatenated encoding a digital signal, the method comprising the steps of:

Reed-Solomon encoding the digital signal;

generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder, said encoder including a finite state machine which advances multiple states for each of a plurality of hi-dimensional signaling intervals, where N>N'≧1, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal having an integer number of bits per each P-dimensional signal point.

5. The method as defined in claim 4 wherein the step of generating symbols includes the step of interleaving the Reed-Solomon encoded signal.

6. A method of transmitting a digital signal over a television channel, the method comprising the steps of:

Reed-Solomon encoding the digital signal;

generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional code within an N-dimensional trellis code, where N>N'≧1, said convolutional code being used to generate for each of a plurality of N-dimensional signaling intervals a plurality of groups of outputs each said group of outputs being a function of a respective different group of inputs;

representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where J×P=N and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral;

generating a modulated signal which represents the resulting sequence of signal point representations; and

applying said modulated signal to said television channel.

7. The method as defined in claim 6 wherein the step of generating symbols includes the steps of interleaving the Reed-Solomon encoded signal and trellis encoding the resulting interleaved signal.

8. The method as defined in claim 6 wherein the trellis code is a four-dimensional trellis code and the convolutional code is a two-dimensional convolutional code.

9. The method as defined in claim 8 wherein the convolutional code is a K-state, rate ½ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

10. The method as defined in claim 6 wherein the television channel is an over-the-air channel and wherein P equals 1.

11. The method as defined in claim 10 wherein the trellis code is a four dimensional trellis code and the convolutional code is a two-dimensional convolutional code.

12. The method as defined in claim 11 wherein the convolutional code is a K-state, rate ½ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

13. The method as defined in claim 6 wherein the television channel is an over-the-air channel and wherein P equals 2.

14. The method as defined in claim 13 wherein the trellis code is a four dimensional trellis code and the convolutional codeis a two-dimensional convolutional code.

15. The method as defined in claim 14 wherein the convolutional code is a K-state, rate ½ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

16. An N-dimensional trellis coded modulator comprising

means for receiving a digital signal, and

an N'-dimensional convolutional encoder for generating a sequence of N-dimensional symbols as a function of the digital signal, where N>N'≧1, said encoder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, the N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point.

17. The modulator as defined in claim 16 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, wherein the modulator further includes:

means for applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

means responsive to output bits from convolutional encoding of all groups of bits included in said first portion for identifying an N-dimensional subset of an N-dimensional constellation; and

means responsive to said second portion for specifying, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

18. The modulator as defined in claim 17 wherein said subset of said N-dimensional constellation consists of a sequence of (N/N')N'-dimensional subsets, wherein each N'-dimensional subset is identified by the convolutional encoder output for a particular group of bits.

19. Apparatus for concatenated encoding a digital signal, the apparatus comprising:

means for Reed-Solomon encoding the digital signal, and

means for generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder, said encoder being used to generate for each N-dimensional signaling interval a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, where N>N'≧1, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal

having an integer number of bits per each P-dimensional signal point.

20. The apparatus as defined in claim 19 wherein the means for generating symbols includes means for interleaving the Reed-Solomon encoded signal.

21. Apparatus for transmitting a digital signal over a television channel, the apparatus comprising:

means for Reed-Solomon encoding the digital signal;

means for generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder within an N-dimensional trellis encoder, said convolutional coder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, where N>N'≧1;

means for representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where J×P=N and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral;

means for generating a modulated signal which represents the resulting sequence of signal point representations; and

means for applying said modulated signal to said television channel.

22. The apparatus as defined in claim 21 wherein means for generating symbols includes means for interleaving the Reed-Solomon encoded signal and means for trellis encoding the resulting interleaved signal.

23. The apparatus as defined in claim 21 wherein the trellis encoder is a four-dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

24. The apparatus as defined in claim 23 wherein the convolutional encoder is a K-state, rate ½ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

25. The apparatus as defined in claim 21 wherein the television channel is an over-the-air channel and wherein P is equal to 1.

26. The apparatus as defined in claim 25 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

27. The apparatus as defined in claim 26 wherein the convolutional encoder is a K-state, rate ½ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

28. The apparatus as defined in claim 21 wherein the television channel is an over-the-air channel and wherein P is equal to 2.

29. The apparatus as defined in claim 28 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

30. The apparatus as defined in claim 29 wherein the convolutional encoder is a K-state, rate ½ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

31. A method of processing a signal from a communication channel, said signal having been generated by encoding a digital signal using N-dimensional trellis coded modulation, wherein the encoding comprised the step of generating a sequence of N-dimensional symbols as a function of the digital signal using an N'-dimensional convolutional encoder, said encoder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, where N>N'≧1, the N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point, the method including the steps of:

receiving said signal from said communication channel, and

recovering said digital signal from said received communication channel signal.

32. The method as defined in claim 31 wherein the recovering step includes the steps of:

demodulating said received communication channel signal to generate a demodulated signal;

processing the demodulated signal to recover said digital signal.

33. The method as defined in claim 32 wherein the processing step includes the step of Viterbi decoding said demodulated signal by using an N'-dimensional Viterbi decoder.

34. The method as defined in any one of claims 31 through 33 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating said sequence of N-dimensional symbols further included the steps of:

applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and

using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

35. A method of processing a signal from a television channel, said signal having been generated by Reed-Solomon encoding a digital signal, generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder within an N-dimensional trellis encoder, said convolutional coder including a finite state machine which advances multiple states for each N-dimensional symbol interval, where N>N'≧1, representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where J×P=N and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral, generating a modulated signal which represents the resulting sequence of signal point representations, and applying said modulated signal to said television channel, the method including the steps of:

receiving said signal from said television channel, and

recovering said digital signal from said received television channel signal.

36. The method as defined in claim 35 wherein the trellis encoder is a four-dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

37. The method as defined in claim 36 wherein the convolutional encoder is a K-state, rate ½ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

38. The method as defined in claim 35 wherein the television channel is an over-the-air channel and wherein P equals 1.

39. The method as defined in claim 38 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

40. The method as defined in claim 39 wherein the convolutional encoder is a K-state, rate ½ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

41. The method as defined in claim 35 wherein the television channel is an over-the-air channel and wherein P equals 2.

42. The method as defined in claim 41 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

43. The method as defined in claim 42 wherein the convolutional encoder is a K-state, rate ½ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

44. A method of processing a signal from a communication channel, said signal having been generated by concatenated encoding a digital signal using N-dimensional trellis coded modulation, wherein the encoding comprised the steps of Reed-Solomon encoding the digital signal and generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder, where $N>N'\geqq 1$, said encoder being used to generate for each N-dimensional symbol interval a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal having an integer number of bits per each P-dimensional signal point, the method including the steps of:

receiving said signal from said communication channel, and

recovering said digital signal from said received communication channel signal.

45. The method as defined in any one of claims 34–36 wherein for each N-dimensional signaling interval, the Reed-Solomon encoded signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating further including the steps of:

applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and

using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

46. The invention as defined in any one of claims 4, 16, 21, 31 or 35, wherein said finite state machine that advances N/N' states for each of the plurality of N-dimensional signaling intervals.

47. The invention as defined in any one of claims 1, 6, 19 or 34, wherein said plurality of groups of outputs is comprised of N/N' groups of outputs and said respective different group of inputs is one of N/N' groups of inputs.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : **5,706,312**
DATED : **January 6, 1998**
INVENTOR(S) : **Lee-Fang Wei**

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, line 35, change "hi-dimensional" to --N-dimensional--.
line 52, change "outputs each" to --outputs, each--.
Column 9, line 28, change "means for generating symbols" to --the means for generating symbols--.
Column 12, line 5, change "34-36" to --35, 36, or 44--.
line 25, change "34" to --44--.

Signed and Sealed this

Eighth Day of June, 1999

Attest:

Q. TODD DICKINSON

Attesting Officer *Acting Commissioner of Patents and Trademarks*

Exhibit 23

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION
CIVIL ACTION NO. 2:05-CV-443 (TJW)

REMBRANDT TECHNOLOGIES, LP,

Plaintiff,

vs.

COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; and COMCAST OF PLANO, LP,

Defendants.
___________________________________/

*** CONFIDENTIAL TRANSCRIPT ***
ATTORNEYS EYES ONLY

VIDEOTAPED DEPOSITION OF JOSEPH B. KING

Wednesday, November 8, 2006
9:03 a.m. - 2:52 p.m.
Sheraton Sand Key Resort
1160 Gulf Boulevard
Clearwater Beach, Florida 33767

REPORTED BY:
MICHELLE OLSEN BADEN, RPR, FPR
Notary Public
State of Florida at Large
Esquire Deposition Services - Tampa, Florida
813-221-2535 (800-838-2814)
Job No.: N635084

APPEARANCES:

MICHAEL BUNIS, ESQUIRE
FISH & RICHARDSON, P.C.
225 Franklin Street
Boston, Massachusetts 02110
617-542-5070

Attorney for Plaintiff, REMBRANDT TECHNOLOGIES, LP

BRIAN FERRALL, ESQUIRE
KEKER & VAN NEST
710 Sansome Street
San Francisco, California 94111-1704
415-391-5400

Attorney for Defendant, COMCAST CORPORATION; COMCAST CABLE COMMUNICATIONS, LLC; and COMCAST OF PLANO, LP

Also Present: Timothy Kyle, Videographer

Q Were the applications that you had contemplating -- contemplated running with your invention the same sort of applications as would be running on the multiple virtual DCE?

MR. BUNIS: Objection.

THE WITNESS: They didn't have to be. Really, this was transparent to the application but, in all reality, it probably would have been. That was a market we were selling into, but it's not restricted to that.

BY MR. FERRALL:

Q Understood it's not restricted but from a business perspective, you were looking for something that was going to work with similar type applications, right?

A I'm sure that was our initial target.

Q And just so I understand, those applications would actually run on the remote as well as the master; is that right?

MR. BUNIS: Objection.

THE WITNESS: That's correct. Both ends, of course, had to serve the same application.

BY MR. FERRALL:

Q So there would be, for example, some software on the remote that might have allowed you to input sales

<u>Exhibit 24</u>

NEWTON'S TELECOM DICTIONARY

The Official Dictionary of Computer Telephony, Telecommunications, Networking and Voice Processing

HARRY NEWTON

World's No. 1 Selling Telecommunications Dictionary

7th Expanded Edition and Updated Edition

A Flatiron Publishing, Inc. Book
Published by Flatiron Publishing, Inc.
Copyright 1994 by Harry Newton

All rights reserved under International and Pan-American Copyright conventions, including the right to reproduce this book or portions thereof in any form whatsoever. Published in the United States by Flatiron Publishing, Inc., New York.

ISBN 0-936648-47-3

Manufactured in the United States of America

Seventh Edition, April 1994
Cover Designed by Saul Roldan
Printed at Bookcrafters, Chelsea, MI.

I wrote thi

Most technical di
result they leave
definitions tell yo
are, what its neg
sionally some wa

This is a working
posals to custom
Users explain tele
understand telec
to your boss. You

I don't claim my d
I add, re-work an
tion. Send me yc
saries. The best
reach it from Inter

HOW TO USE

My definitions are
alphabetical order
dictionary:

Blank Space
& (Ampersand)
Hyphen -
Period .
/ (Forward slash)
0 (zero)
1
2
3
4
5

SYNCHRONIZATION PULSE A pulse used to achieve or maintain synchronism. The term "synchronization pulse" is usually applied to analog signals, whereas the term "synchronization bit" is usually applied to digital data streams.

SYNCHRONIZING Achieving and maintaining synchronism. In facsimile, achieving and maintaining predetermined speed relations between the scanning spot and the recording spot within each scanning line.

SYNCHRONIZING PILOT In FDM, a reference frequency used for achieving and maintaining synchronization of the oscillators of a carrier system or for comparing the frequencies or phases of the currents generated by those oscillators.

SYNCHRONOUS 1. The condition that occurs when two events happen in a specific time relationship with each other and both are under control of a master clock. 2. Synchronous transmission means there is a constant time between successive bits, characters or events. The timing is achieved by the sharing of a single clock. Each end of the transmission synchronizes itself with the use of clocks and information sent along with the transmitted data. Synchronous is the most popular communications method to and from mainframes. In synchronous transmission, characters are spaced by time, not by start and stop bits. Because you don't have to add these bits, synchronous transmission of a message will take fewer bits (and therefore less time) than an asynchronous transmission. But because precise clocks and careful timing are needed in synchronous transmission, it's usually more expensive to set up synchronous transmission. See ASYNCHRONOUS

SYNCHRONOUS DATA LINK CONTROL SDLC. A data communications line protocol associated with the IBM Systems Network Architecture. See SYSTEMS NETWORK ARCHITECTURE.

SYNCHRONOUS DATA NETWORK A data network in which synchronism is achieved and maintained between data circuit-terminating equipment (DCE) and the data switching exchange (DSE), and between DSEs. The data signaling rates are controlled by timing equipment within the network.

SYNCHRONOUS DIGITAL HIERARCHY SDH. Term used by the International Telegraph and Telephone Consultative Committee to refer to Sonet.

SYNCHRONOUS IDLE CHARACTER A transmission control character used in synchronous transmission systems to provide a signal from which synchronism or synchronous correction may be achieved between data terminal equipment, particularly when no other character is being transmitted.

SYNCHRONOUS NETWORK A network in which all the communication links are synchronized to a common clock.

SYNCHRONOUS ORBIT An orbit, any point on which has a period equal to the average rotational period of the Earth. If the orbit is also circular and equatorial, it is called a stationary (geostationary) orbit.

power (up to four WATTS permitted) public radio. You do not need permission from the FCC to transmit or receive at these frequencies. Thus CB's great popularity. CB went through a boom (perhaps a craze?), then it ran out of radio frequencies and public enthusiasm. Its original frequencies were 26.965 to 27.225 Mhz. Now the FCC's given it new frequencies — 462.55 to 469.95 MHz. These new frequencies are much better, clearer and less congested. If you buy a CB set, make sure you get one that operates in these higher frequencies. In some countries they use different frequencies. CB radio is not allowed in many countries, even some civilized countries, though it will obviously work there.

CBEMA Computer Business Equipment Manufacturers Association. A lobbying group created to protect the interests of its members.

CBF Computer Based Fax.

CBK Change BacK.

CBR Constant Bit Rate. It refers to processes such as voice that require a constant, repetitive or uniform transfer of information.

CBTA Canadian Business telecommunications Alliance. The largest organization of business telecom users in Canada.

CBX Computerized Branch eXchange. CBX is a registered trademark of the ROLM Corporation, Santa Clara, CA. Rolm is now owned by Siemens and IBM, but largely by Siemens. What CBX is to Rolm, PBX or PABX is to other companies. The term CBX has not received wide acceptance, except at Rolm.

CBX II A Rolm communications controller for larger systems. Two versions exist: the CBX II 8000 (16-bit CPU) and the CBX II 9000 (32-bit CPU).

CCC 1. Clear Coded Channel. A 64 kbps channel in which all 64 kbps is available for data. 2. Clear Channel Capability. The bandwidth of a data transmission path available to end users after control and signaling bits are accounted for. 3. Communications Competition Coalition. Lobbying organization established to encourage competition in telecommunications in Canada.

CCD 1. Charge Coupled Device. The "eyes" of a scanner or "digital camera." CCDs are small electronic devices with arrays of light-sensitive elements. The number of these elements and the width determine the scanner's or camera's resolution. Light is bounced off the image onto the CCD, which translates the varying intensities of the reflected light into digital data. CCD technology is used also in "digital still cameras" such as the Sony Mavica. The small size of the array itself — approximately microchip size — and the high resolution — around 1,000 by 1,018 elements — of these cameras have greatly improved "image acquisition" capabilities and opened up new applications in manufacturing quality control and in medicine. 2. Change Coupled Device.

CCDN Corporate Consolidated Data Network. An IBM word.

CCFL Cold Cathode Fluorescent Lamp. A technology several laptop computer manufacturers use to light their LCD screens.

CCIA Coı
zation of
services (
lobbying a
bers. See

CCIR C
(Consulta
Also usec
Europe. T
be 1,125.

CCIR 6
of compo
the EBU
with lumi
nents) sa
channel.
(NTSC) a
fies that
tape form

CCIR 6
interfaces
the serial
chronizat

CCIS Co
signaling
CCIS occ
rate from
#7. SS#7
matically
it allows
is carriec
the callin

Signaling
the inforr
signaling
down the
ing the si
nity coulc
cated the
more effi
channel
coming i
NEL SIG
INTERO

REM 0086604